A Biological Assessment of Sites in the Blackfoot River Watershed: Missoula, Powell, and Lewis and Clark Counties, Montana Project TMDL-C03 2003

By W. Bollman

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A BIOLOGICAL ASSESSMENT OF SITES IN THE BLACKFOOT RIVER WATERSHED: MISSOULA, POWELL, AND LEWIS AND CLARK COUNTIES, MONTANA

Project TMDL-C03

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A report to

The Montana Department of Environmental Quality
Planning, Prevention and Assistance Division
Helena, Montana
Andy Welch, Project Officer

by

Wease Bollman
Rhithron Associates, Inc.
Missoula, Montana
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INTRODUCTION

Aquatic invertebrates are aptly applied to bioassessment since they are known to be important indicators of stream ecosystem health (Hynes 1970). Long lives, complex life cycles, and limited mobility mean that there is ample time for the benthic community to respond to cumulative effects of environmental perturbations.

This report summarizes data collected in September and October 2003 from 31 sites in the Blackfoot River Watershed, in Missoula, Powell, and Lewis and Clark Counties, Montana. Some sites in this study lie within the Montana Valley and Foothill Prairies (MVFP) ecoregion (Woods et al. 1999) and others in the Northern Rockies ecoregion.

A multimetric approach to bioassessment such as the one applied in this study uses attributes of the assemblage in an integrated way to measure biotic health. A stream with good biotic health is "...a balanced, integrated, adaptive system having the full range of elements and processes that are expected in the region's natural environment..." (Karr and Chu 1999). The approach designed by Plafkin et al. (1989) and adapted for use in the State of Montana has been defined as "... an array of measures or metrics that individually provide information on diverse biological attributes, and when integrated, provide an overall indication of biological condition." (Barbour et al. 1995). Community attributes that can contribute meaningfully to interpretation of benthic data include assemblage structure, sensitivity of community members to stress or pollution, and functional traits. Each metric component contributes an independent measure of the biotic integrity of a stream site; combining the components into a total score reduces variance and increases precision of the assessment (Fore et al. 1996). Effectiveness of the integrated metrics depends on the applicability of the underlying model, which rests on a foundation of three essential elements (Bollman 1998a). The first of these is an appropriate stratification or classification of stream sites, typically by ecoregion. Second, metrics must be selected based upon their ability to accurately express biological condition. Third, an adequate assessment of habitat conditions at each site to be studied enhances the interpretation of metric outcomes.

Implicit in the multimetric method and its associated habitat assessment is an assumption of correlative relationships between habitat measures and the biotic metrics, in the absence of water quality impairment. These relationships may vary regionally, requiring an examination of habitat assessment elements and biotic metrics and a test of the presumed relationship between them. Bollman (1998a) has studied the assemblages of the Montana Valleys and Foothill Prairies ecoregion and has recommended a battery of metrics applicable to the montane ecoregions of western Montana. This metric battery has been shown to be sensitive to impairment, related to measures of habitat integrity, and consistent over replicated samples.

In this report, 3 assessment methods are used: first, taxonomic data is translated in to 2 bioassessment indices, and metric scores in each index are summed to derive impairment classifications and use support designations. Second, a narrative interpretation, based on the author's professional judgment is given. Metric performance and taxonomic data are both applied to this analysis. Third, the model of Barbour and Stribling (1991) is applied to bioassessment and habitat assessment scores. While the interdependence of these methods is obvious, since the same data are used for all, some degree of independence is maintained throughout the analysis. Narrative interpretations are given without regard to the bioassessment index result, and without reference to habitat assessment. Since indices are summations, they can often mask evidence of impairment; the narratives attempt to expose the potential shortcomings of the indices. Similarly, graphing the association between habitat assessment scores and bioassessment scores using the model of Barbour and Stribling can provide clues to offer support or possible refutation of the conclusions of the narrative analysis.

METHODS

Samples were collected in September 2003 by Montana DEQ personnel. Sample designations and site locations are indicated in Tables 1a and 1b, and approximate locations are illustrated in Figures 1a and 1b. The site selection and sampling method employed were those recommended in the Montana Department of Environmental Quality (DEQ) Standard Operating Procedures for Aquatic Macroinvertebrate Sampling (Bukantis 1998). Aquatic invertebrate samples were delivered to Rhithron Associates, Inc., Missoula, Montana, for laboratory and data analyses.

In the laboratory, the Montana DEQ-recommended sorting method was used to obtain subsamples of at least 300 organisms from each sample, when possible. When a sample contained fewer than 300 organisms, the entire sample was sorted. Organisms were identified to the lowest possible taxonomic levels consistent with Montana DEQ protocols.

To assess aquatic invertebrate communities, a multimetric index developed in previous work for streams of western Montana ecoregions (Bollman 1998a) was used. Multimetric indices result in a single numeric score, which integrates the values of several individual indicators of biologic health. Each metric used in this index was tested for its response or sensitivity to varying degrees of human influence. Correlations have been demonstrated between the metrics and various symptoms of human-caused impairment as expressed in water quality parameters or instream, streambank, and stream reach morphologic features. Metrics were screened to minimize variability over natural environmental gradients, such as site elevation or sampling season, which might confound interpretation of results (Bollman 1998a). The multimetric index used in this report incorporates multiple attributes of the sampled assemblage into an integrated score that accurately describes the benthic community of each site in terms of its biologic integrity. In addition to the metrics comprising the index, other metrics shown to be applicable to biomonitoring in other regions (Kleindl 1995, Patterson 1996, Rossano 1995) were used for descriptive interpretation of results. These metrics include the number of "clinger" taxa, long-lived taxa richness, the percent of predatory organisms, and others. They are not included in the integrated bioassessment score, however, since their performance in western Montana ecoregions is unknown. However, the relationship of these metrics to habitat conditions is intuitive and reasonable.

The six metrics constituting the bioassessment index used for MVFP sites in this study were selected because, both individually and as an integrated metric battery, they are robust at distinguishing impaired sites from relatively unimpaired sites (Bollman 1998a). In addition, they are relevant to the kinds of impacts that are present in the Blackfoot River watershed. They have been demonstrated to be more variable with anthropogenic disturbance than with natural environmental gradients (Bollman 1998a). Each of the six metrics developed and tested for western Montana ecoregions is described below.

1. **Ephemeroptera (mayfly) taxa richness.** The number of mayfly taxa declines as water quality diminishes. Impairments to water quality which have been demonstrated to adversely affect the ability of mayflies to flourish include elevated water temperatures, heavy metal contamination, increased turbidity, low or high pH, elevated specific conductance and toxic chemicals. Few mayfly species are able to tolerate certain disturbances to instream habitat, such as excessive sediment deposition.
2. **Plecoptera (stonefly) taxa richness.** Stoneflies are particularly susceptible to impairments that affect a stream on a reach-level scale, such as loss of riparian canopy, streambank instability, channelization, and alteration of morphological features such as pool frequency and function, riffle development and sinuosity. Just as all benthic organisms, they are also susceptible to smaller scale habitat loss, such as by sediment deposition, loss of interstitial spaces between substrate particles, or unstable substrate.

Table 1a. Sample designations and locations. Sites are listed in upstream-to-downstream order relative to the Blackfoot River, and within specific tributary watersheds. Blackfoot River watershed, September –October 2003.

Site ID	Station ID	Activity ID	Location Description	Sample date	Latitude	Longitude
SVNPC01	C03SVNPC01	03-C329-M	Seven-up Pete Creek headwaters of creek	10/24/2003	46-56-44.154	112-31-24.612
ROCKC10	C03ROCKC10	03-C243-M	Rock Creek-Upper at State land, sec 24	09/11/2003	47-2-10	112-55-25
ROCKC20	C03ROCKC10	03-C242-M	Rock Creek-Lower 150 yds u/s from hwy 200	09/11/2003	47-0-3	113-1-55
KLSMC01	C03KLSMC10	03-C241-M	Kleinschmidt Creek 200 yds u/s of mouth Rock Creek	09/11/2003	46-59-58	*113-1-51*
MONTC10	C03MONTC10	03-C240-M	Monture Creek upper u/s from Monture Cr. C.G. 100 yds.	09/11/2003	47-7-34	113-8-47
MONTC20	C03MONTC20	03-C239-M	Monture Creek Middle 0.5 mile u/s of hwy 141	09/10/2003	47-3-7	113-10-57
MONTC30	C03MONTC30	03-C238-M	Monture Creek lower 0.5 mile u/s from mouth	09/10/2003	47-1-56	113-13-1
WASHC10	C03WASHC10	03-C320-M	Washington Creek 50 yds u/s of Cow Gulch	09/28/2003	46-47-7	112-39-55
WASHC20	C03WASHC20	03-C321-M	Washington Creek 150 yds u/s of hwy 141 Rd Crossing	09/28/2003	46-45-45	112-42-0
JEFSC10	C03JEFSC10	03-C322-M	Jefferson Creek 1.5 miles u/s of Madison Gulch	09/29/2003	46-48-8	112-41-37
JEFSC20	C03JEFSC20	03-C323-M	Jefferson Creek 50 yds u/s of Madison Gulch confluence	09/29/2003	46-47-32	112-42-54
JEFSC30	C03JEFSC30	03-C324-M	Jefferson Creek 100 yds u/s of hwy 141 crossing	09/29/2003	46-46-34	112-44-18
GALGC10	C03GALGC10	03-C319-M	Gallagher Creek 150 yds u/s from mouth Nevada Cr.	09/28/2003	46-46-18	112-44-55
BUFLG10	C03BUFLG10	03-C312-M	Buffalo Gulch 100 yds u/s from where diverges from road	09/25/2003	46-48-37	112-44-27
BUFLG20	C03BUFLG20	03-C311-M	Buffalo Gulch 0.5 mile u/s from mouth	09/25/2003	46-47-47	112-46-19
BRZLC10	C03BRZLC10	03-C325-M	Braziel Creek 50 yds u/s of Nevada Cr Rd crossing	09/29/2003	46-48-25	112-50-18
BKBRC10	C03BKBRC10	03-C313-M	Black Bear Creek 250 yds u/s from mouth Bear Creek	09/26/2003	46-46-33	113-5-37
MURYC10	C03MURYC10	03-C315-M	Murray Creek 100 yds u/s from highest road crossing	09/26/2003	46-48-29	113-8-10
MURYC20	C03MURYC20	03-C314-M	Murray Creek 100 yds u/s of lowest road crossing	09/26/2003	46-48-31	113-4-55

Table 1b. Sample designations and locations. Sites are listed in upstream-to-downstream order relative to the Blackfoot River, and within specific tributary watersheds. Blackfoot River Watershed, September 2003.

Site ID	Station ID	Activity ID	Location Description	Sample date	Latitude	Longitude
DOUGC10	C03DOUGC10	03-C316-M	Douglas Creek 150 yds u/s from second reservoir	09/27/2003	46-47-7	113-7-39
DOUGC20	C03DOUGC20	03-C317-M	Douglas Creek 0.25 mi u/s of Murray Cr. Confluence	09/27/2003	46-48-3	113-3-52
DOUGC30	C03DOUGC30	03-C318-M	Douglas Creek 1.25 miles u/s from mouth	09/27/2003	46-51-41	113-0-9
YRNMC20	C03YRNMC20	03-C244-M	Yourname Creek 300 yds d/s from bridge	09/12/2003	46-53-52	113-6-5
WALSC10	C03WALSC10	03-C309-M	Wales Creek 0.25 mi u/s from mouth	09/15/2003	46-55-40	113-6-48
FRZRC10	C03FRZRC10	03-C310-M	Frazier Creek 200 yds u/s of mouth	09/25/2003	46-56-20	113-7-24
RHMDC01	C03RHMDC01	03-C245-M	Richmond Creek 50 yds u/s of logging rd crossing	09/13/2003	47-19-37	113-34-32
CLRWF10	C03CLRWF10	03-C246-M	Clearwater River West Fork upper	09/13/2003	47-18-15	113-36-22
CLRWF20	C03CLRWF20	03-C247-M	Clearwater River West Fork lower	09/13/2003	47-15-10	113-35-0
DEERC10	C03DEERC10	03-C248-M	Deer Creek upper 150 yds d/s from FS 5560 bridge crossing	09/14/2003	47-14-1	113-39-18
DEERC20	C03DEERC20	03-C249-M	Deer Creek lower 100 yds u/s of FS 2190 bridge crossing	09/14/2003	47-12-41	113-33-18
BLHDC10	C03BLHDC10	03-C308-M	Blanchard Creek lower reach	09/14/2003	47/0/18	113-24-18

Figure 1a. Approximate locations of sampling sites. Blackfoot River watershed, September-October 2003.

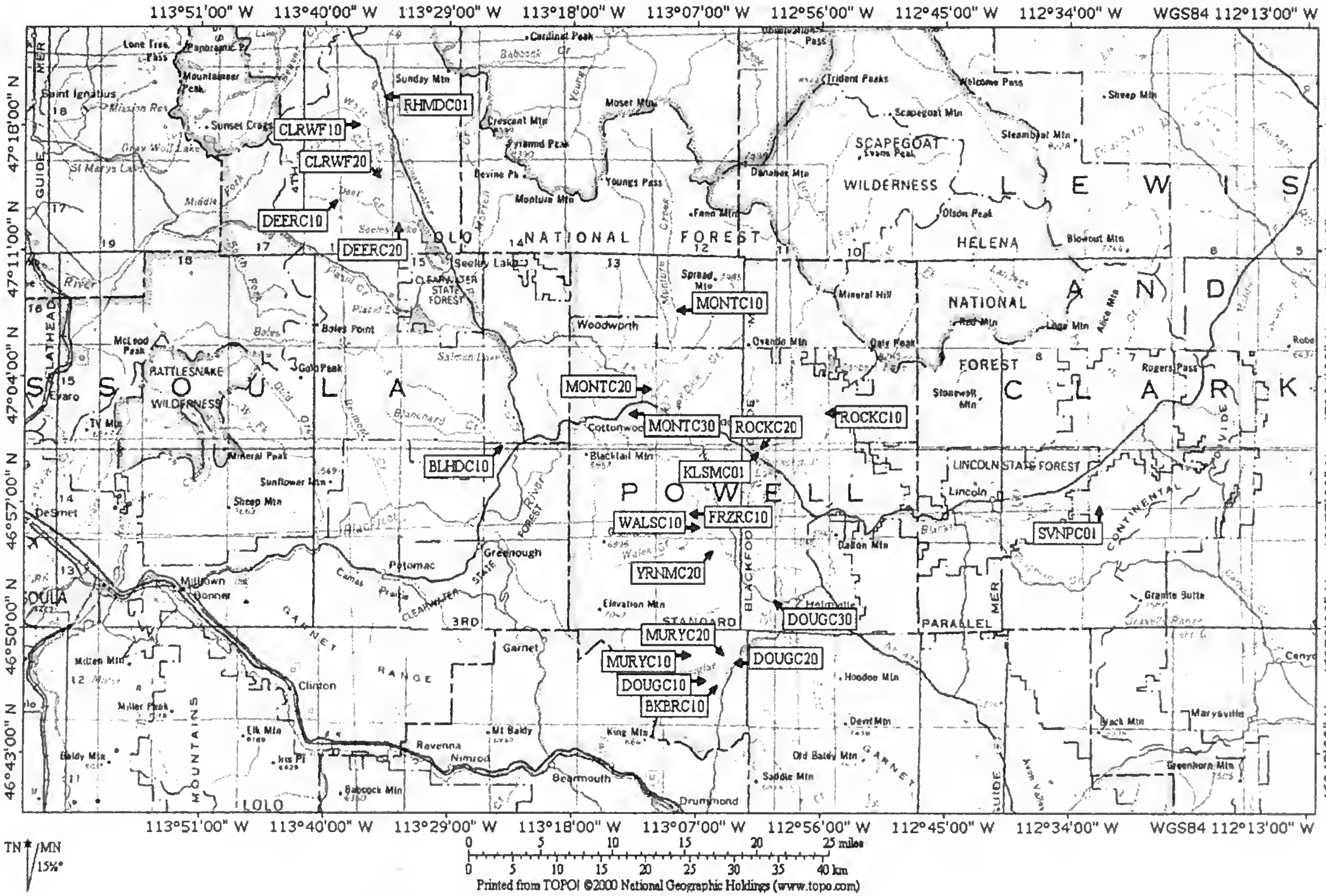
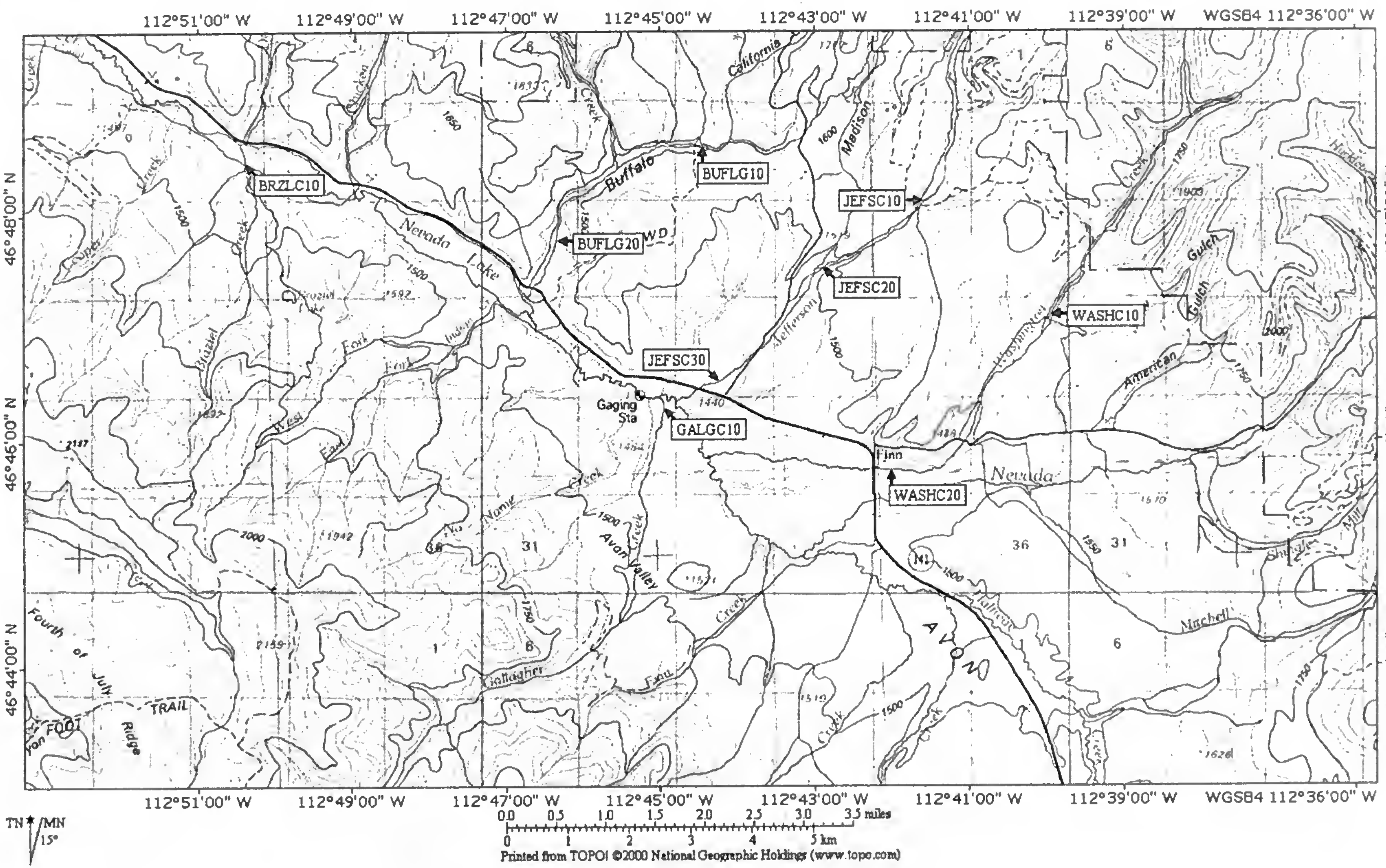


Figure 1b. Approximate locations of sampling sites. Blackfoot River watershed, upper Nevada Creek drainage. September-October 2003.



3. Trichoptera (caddisfly) taxa richness. Caddisfly taxa richness has been shown to decline when sediment deposition affects habitat. In addition, the presence of certain case-building caddisflies can indicate good retention of woody debris and lack of scouring flow conditions.

4. Number of sensitive taxa. Sensitive taxa are generally the first to disappear as anthropogenic disturbances increase. The list of sensitive taxa used here includes organisms sensitive to a wide range of disturbances, including warmer water temperatures, organic or nutrient pollution, toxic pollution, sediment deposition, substrate instability and others. Unimpaired streams of western Montana typically support at least four sensitive taxa (Bollman 1998a).

5. Percent filter feeders. Filter-feeding organisms are a diverse group; they capture small particles of organic matter, or organically enriched sediment material, from the water column by means of a variety of adaptations, such as silken nets or hairy appendages. In forested montane streams, filterers are expected to occur in insignificant numbers. Their abundance increases when canopy cover is lost and when water temperatures increase and the accompanying growth of filamentous algae occurs. Some filtering organisms, specifically the Arctopsychid caddisflies (*Arctopsyche* spp. and *Parapsyche* spp.) build silken nets with large mesh sizes that capture small organisms such as chironomids and early-instar mayflies. Here they are considered predators, and, in this study, their abundance does not contribute to the percent filter feeders metric.

6. Percent tolerant taxa. Tolerant taxa are ubiquitous in stream sites, but when disturbance increases, their abundance increases proportionately. The list of taxa used here includes organisms tolerant of a wide range of disturbances, including warmer water temperatures, organic or nutrient pollution, toxic pollution, sediment deposition, substrate instability and others.

Scoring criteria for each of the six metrics are presented in Table 2. Metrics differ in their possible value ranges as well as in the direction the values move as biological conditions change. For example, Ephemeroptera richness values may range from zero to ten taxa or higher. Larger values generally indicate favorable biotic conditions. On the other hand, the percent filterers metric may range from 0% to 100%; in this case, larger values are negative indicators of biotic health. To facilitate scoring, therefore, metric values were transformed into a single scale. The range of each metric has been divided into four parts and assigned a point score between zero and three. A score of three indicates a metric value similar to one characteristic of a non-impaired condition. A score of zero indicates strong deviation from non-impaired condition and suggests severe degradation of biotic health. Scores for each metric were summed to give an overall score, the total bioassessment score, for each site in each sampling event. These scores were expressed as the percent of the maximum possible score, which is 18 for this metric battery. The total bioassessment score for each site was expressed in terms of use-support. Criteria for use-support designations were developed by Montana DEQ and are presented in Table 3a. Scores were also translated into impairment classifications according to criteria outlined in Table 3b.

Table 2. Metrics and scoring criteria for bioassessment of streams of the Montana Valley and Foothill Prairies ecoregion (Bollman 1998a).

	Score			
Metric	**3**	**2**	**1**	**0**
Ephemeroptera taxa richness	> 5	5 - 4	3 – 2	< 2
Plecoptera taxa richness	> 3	3 - 2	1	0
Trichoptera taxa richness	> 4	4 - 3	2	< 2
Sensitive taxa richness	> 3	3 - 2	1	0
Percent filterers	0 – 5	5.01 - 10	10.01 – 25	> 25
Percent tolerant taxa	0 – 5	5.01 - 10	10.01 – 35	> 35

Table3a. Criteria for the assignment of use-support classifications / standards violation thresholds (Bukantis 1998).

% Comparability to reference	Use support
>75	Full support--standards not violated
25-75	Partial support--moderate impairment--standards violated
<25	Non-support--severe impairment--standards violated

Table3b. Criteria for the assignment of impairment classifications (Plafkin et al. 1989).

% Comparability to reference	Classification
> 83	nonimpaired
54-79	slightly impaired
21-50	moderately impaired
<17	severely impaired

In this report, certain other metrics were used as descriptors of the benthic community response to habitat or water quality but were not incorporated into the bioassessment metric battery, either because they have not yet been tested for reliability in streams of western Montana, or because results of such testing did not show them to be robust at distinguishing impairment, or because they did not meet other requirements for inclusion in the metric battery. These metrics and their use in predicting the causes of impairment or in describing its effects on the biotic community are described below.

- The modified biotic index. This metric is an adaptation of the Hilsenhoff Biotic Index (HBI, Hilsenhoff 1987), which was originally designed to indicate organic enrichment of waters. Values of this metric are lowest in least impacted conditions. Taxa tolerant to saprobic conditions are also generally tolerant of warm water, fine sediment and heavy filamentous algae growth (Bollman 1998b). Loss of canopy cover is often a contributor to higher biotic index values. The taxa values used in this report are modified to reflect habitat and water

quality conditions in Montana (Bukantis 1998). Ordination studies of the benthic fauna of Montana's foothill prairie streams showed that there is a correlation between modified biotic index values and water temperature, substrate embeddedness, and fine sediment (Bollman 1998a). In a study of reference streams, the average value of the modified biotic index in least-impaired streams of western Montana was 2.5 (Wisseman 1992).

- Taxa richness. This metric is a simple count of the number of unique taxa present in a sample. Average taxa richness in samples from reference streams in western Montana was 28 (Wisseman 1992). Taxa richness is an expression of biodiversity, and generally decreases with degraded habitat or diminished water quality. However, taxa richness may show a paradoxical increase when mild nutrient enrichment occurs in previously oligotrophic waters, so this metric must be interpreted with caution.
- Percent predators. Aquatic invertebrate predators depend on a reliable source of invertebrate prey, and their abundance provides a measure of the trophic complexity supported by a site. Less disturbed sites have more plentiful habitat niches to support diverse prey species, which in turn support abundant predator species.
- Number of "clinger" taxa. So-called "clinger" taxa have physical adaptations that allow them to cling to smooth substrates in rapidly flowing water. Aquatic invertebrate "clingers" are sensitive to fine sediments that fill interstices between substrate particles and eliminate habitat complexity. Animals that occupy the hyporheic zones are included in this group of taxa. Expected "clinger" taxa richness in unimpaired streams of western Montana is at least 14 (Bollman 1998b).
- Number of long-lived taxa. Long-lived or semivoltine taxa require more than a year to completely develop, and their numbers decline when habitat and/or water quality conditions are unstable. They may completely disappear if channels are dewatered or if there are periodic water temperature elevations or other interruptions to their life cycles. Western Montana streams with stable habitat conditions are expected to support six or more long-lived taxa (Bollman 1998b).

RESULTS

Bioassessment

Figure 2 summarizes bioassessment scores for aquatic invertebrate communities sampled from sites in the Blackfoot River watershed. Tables 4a through 4d itemize each contributing metric and show individual metric scores for each site. Tables 3a and 3b above show criteria for impairment classifications (Plafkin et al. 1989) and use-support categories recommended by Montana DEQ (Bukantis 1998).

When this method is applied to these data, scores suggest that 12 sites were essentially non-impaired and fully supported designated uses. These sites were: the site on Seven Up Pete Creek (SVNPC01), the upstream sites on Washington Creek (WASHC10), Jefferson Creek (JEFSC10), and Buffalo Gulch (BUFLG10), the site on Braziel Creek (BRZLC10), the upstream site on Murray Creek (MURYC10), the upstream and middle sites on Monture Creek (MONTC10 and MONTC20), the site on Richmond Creek (RHMDC01), the upstream site on the West Fork Clearwater River (CLRWF10), and both sites on Deer Creek (DEERC10 and DEERC20). Scores indicated slight impairment but full use support at 2 sites. These were the upstream site on Rock Creek (ROCKC10) and the lower site in Buffalo Gulch (BUFLG20). Nine sites scored slight impairment and partial support of designated uses. These were the downstream site on

Rock Creek (ROCKC20), the site on Kleinschmidt Creek (KLSMC01), the site on Washington Creek (WASHC20), the middle site on Jefferson Creek (JEFSC20), the sites on Gallagher Creek and Yourname Creek (GALGC10 and YRNMC20), the lower sites on Monture Creek and the West Fork Clearwater River (MONTC30 and CLRWF20), and the site on Blanchard Creek (BLHDC10). Moderate impairment and partial use support was indicated at 8 sites. These were the lowermost site on Jefferson Creek (JEFSC30), the site on Black Bear Creek (BKBRC10), the lower site on Murray Creek (MURYC20), all 3 sites on Douglas Creek (DOUGC10, DOUGC20 and DOUGC 30), and the sites on Wales Creek and Frazier Creek (WALSC10 and FRZRC10).

Aquatic invertebrate communities

Interpretations of biotic integrity in this report are made without reference to results of habitat assessments, or any other information about the sites or watersheds that may have accompanied the invertebrate samples. Interpretations are based entirely on: the taxonomic and functional composition of the sampled invertebrate assemblages; the sensitivities, tolerances, physiology, and habitus information for individual taxa gleaned from the writer's research; the published literature, and other expert sources; and on the performance of bioassessment metrics, described earlier in the report, which have been demonstrated to be useful tools for interpreting potential implications of benthic invertebrate assemblage composition.

Blackfoot River tributaries

The sampled site at the headwaters of Seven Up Pete Creek (SVNPC01) supported a benthic assemblage characteristic of an unimpaired montane stream. The low biotic index value (2.08) coupled with high mayfly taxa richness (8) suggest excellent water quality. Fifteen cold-stenotherm taxa were collected here, including the mayflies *Baetis bicaudatus* and *Cinygma* sp.; cold, clean water is indicated.

Fifteen "clinger" taxa and 6 caddisfly taxa were present in the sample. These findings imply that sediment deposition did not substantially limit the availability of stony benthic habitats. Sediment sensitive taxa such as *Drunella doddsi* and *Neothremma* sp. were present, if not common. Complex and diverse instream habitats are suggested by the high overall taxa richness (39) and by the diverse predator fauna (11 taxa). At least 11 stonefly taxa were present at the site; stonefly taxa richness may be associated with reach-scale habitat features, such as streambank stability, natural channel morphology, and riparian zone integrity. Three long-lived taxa were collected, including the stonefly *Doroneuria* sp. and the caddisfly *Parapsyche elsis*. The presence of these taxa suggests that dewatering or other catastrophic interruptions of semivoltine life cycles did not limit biotic health in this reach. The functional composition of the sampled assemblage was characteristic of a headwater site; shredders were abundant, implying ample riparian inputs of large organic material and hydrologic conditions and channel complexity adequate to retain it.

Two sites on Rock Creek were sampled. At the upper site (ROCKC10), a large number of the gregarious elmid *Optioservus* sp. were collected, swamping the sample and skewing the biotic index value (4.40) among other metric expressions of assemblage tolerance and function. Sixty-nine percent of sampled animals were in this taxon. Collecting such a sample, where a congregation of a certain taxon is randomly encountered by the sampler, may be a serendipitous event; it renders bioassessment unreliable, since other taxa present at the site are underrepresented in both the sample as well as the randomly selected subsample. If *Optioservus* sp. is excluded from the biotic index calculation for this sample, the resulting value is 3.08, which seems to be more consistent with the high mayfly taxa richness (7) observed here. Although 2 cold stenotherm taxa were collected, neither was common. Good water quality is suggested, though temperatures may have been slightly higher than expected.

Figure 2a. Comparison of total bioassessment scores (reported as percent of maximum score) for 31 sites in the Blackfoot River watershed. September –October 2003. The revised bioassessment method (Bollman 1998a) was used to calculate scores.

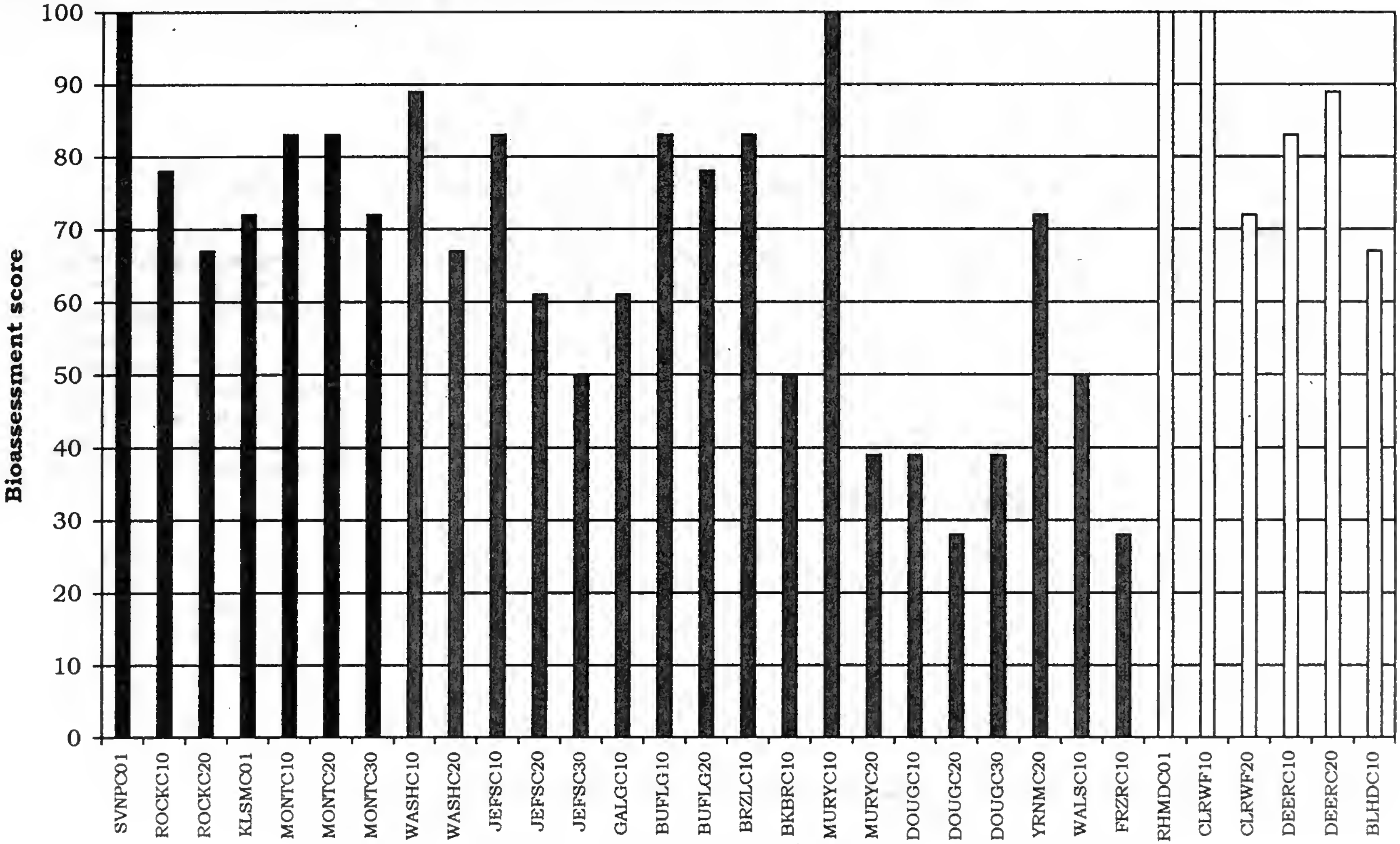


Table 4a. Metric values, scores, and bioassessments for 10 sites in the Blackfoot River watershed, September-October 2003. Site locations are given in Table 1. The revised bioassessment method (Bollman 1998a) was used to calculate scores.

METRICS	SVNPC 01	ROCKC 10	ROCKC 20	KLSMC 01	MONTC 10	MONTC 20	MONTC 30	WASHC 10	WASHC 20	JEFSC 10
METRIC VALUES										
Ephemeroptera richness	8	7	3	5	8	7	3	8	5	5
Plecoptera richness	11	4	3	2	5	2	2	5	4	4
Trichoptera richness	6	5	7	7	1	7	9	9	5	9
Number of sensitive taxa	16	2	1	3	7	2	3	6	1	4
% filterers	4.10	0.31	6.93	16.46	1.56	6.31	5.67	3.57	2.09	3.92
% tolerant taxa	0.00	70.15	2.64	4.66	0.31	3.90	2.33	18.18	45.67	18.07
METRIC SCORES										
Ephemeroptera richness	3	3	1	2	3	3	1	3	2	2
Plecoptera richness	3	3	2	2	3	2	2	3	3	3
Trichoptera richness	3	3	3	3	0	3	3	3	3	3
Number of sensitive taxa	3	2	1	2	3	2	2	3	1	3
% filterers	3	3	2	1	3	2	2	3	3	3
% tolerant taxa	3	0	3	3	3	3	3	1	0	1
TOTAL SCORE (max.=18)	18	14	12	13	15	15	13	16	12	15
PERCENT OF MAX.	**100**	**78**	**67**	**72**	**83**	**83**	**72**	**89**	**67**	**83**
Impairment classification*	**NON**	**SLI**	**SLI**	**SLI**	**NON**	**NON**	**SLI**	**NON**	**SLI**	**NON**
USE SUPPORT †	**FULL**	**FULL**	**PART**	**PART**	**FULL**	**FULL**	**PART**	**FULL**	**PART**	**FULL**

* Impairment classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired. See Table 3b.
† Use support designations: See Table 3a.

Table 4b. Metric values, scores, and bioassessments for 10 sites in the Blackfoot River watershed, September-October 2003. Site locations are given in Table 1. The revised bioassessment method (Bollman 1998a) was used to calculate scores. Impairment classification and Use Support designation for Black Bear Creek are indicated with parentheses; this sample yielded few organisms, rendering bioassessment unreliable.

METRICS	JEFSC 20	JEFSC 30	GALGC 10	BUFLG 10	BUFLG 20	BRZLC 10	BKBRC 10	MURYC 10	MURYC 20	DOUGC 10
METRIC VALUES										
Ephemeroptera richness	4	3	2	6	5	5	2	8	1	2
Plecoptera richness	3	4	4	3	2	3	3	5	2	3
Trichoptera richness	7	9	11	8	9	9	2	5	1	2
Number of sensitive taxa	2	1	1	3	4	3	1	6	2	0
% filterers	6.40	13.55	5.90	1.59	4.85	1.21	0.00	2.99	1.54	0.30
% tolerant taxa	49.39	55.72	18.32	5.40	32.04	2.42	34.90	1.20	45.06	64.97
METRIC SCORES										
Ephemeroptera richness	2	1	1	3	2	2	1	3	0	1
Plecoptera richness	2	3	3	2	2	2	2	3	2	2
Trichoptera richness	3	3	3	3	3	3	1	3	0	1
Number of sensitive taxa	2	1	1	2	3	2	1	3	2	0
% filterers	2	1	2	3	3	3	3	3	3	3
% tolerant taxa	0	0	1	2	1	3	1	3	0	0
TOTAL SCORE (max.=18)	11	9	11	15	14	15	9	18	7	7
PERCENT OF MAX.	**61**	**50**	**61**	**83**	**78**	**83**	**50**	**100**	**39**	**39**
Impairment classification*	**SLI**	**MOD**	**SLI**	**NON**	**SLI**	**NON**	**(MOD)**	**NON**	**MOD**	**MOD**
USE SUPPORT †	**PART**	**PART**	**PART**	**FULL**	**FULL**	**FULL**	**(PART)**	**FULL**	**PART**	**PART**

* Impairment classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired. See Table 3b.
† Use support designations: See Table 3a.

Table 4c. Metric values, scores, and bioassessments for 11 sites in the Blackfoot River watershed, September-October 2003. Site locations are given in Table 1. The revised bioassessment method (Bollman 1998a) was used to calculate scores.

	SITES										
METRICS	DOUGC 20	DOUGC 30	YRNMC 20	WALSC 10	FRZRC 10	RHMDC 01	CLRWF 10	CLRWF 20	DEERC 10	DEERC 20	BLHDC 10
METRIC VALUES											
Ephemeroptera richness	2	2	4	4	1	9	9	9	9	10	3
Plecoptera richness	0	4	3	3	0	8	6	8	5	6	4
Trichoptera richness	6	3	8	6	4	10	12	11	6	9	9
Number of sensitive taxa	1	1	2	0	0	15	11	6	12	10	4
% filterers	30.00	53.67	1.83	13.62	3.01	2.97	4.02	29.85	13.31	10.28	15.22
% tolerant taxa	40.97	57.19	13.15	26.93	42.47	0.00	1.86	10.15	8.67	1.87	14.60
METRIC SCORES											
Ephemeroptera richness	1	1	2	2	0	3	3	3	3	3	1
Plecoptera richness	0	3	2	2	0	3	3	3	3	3	3
Trichoptera richness	3	2	3	3	2	3	3	3	3	3	3
Number of sensitive taxa	1	1	2	0	0	3	3	3	3	3	3
% filterers	0	0	3	1	3	3	3	0	1	1	1
% tolerant taxa	0	0	1	1	0	3	3	1	2	3	1
TOTAL SCORE (max.=18)	5	7	13	9	5	18	18	13	15	16	12
PERCENT OF MAX.	**28**	**39**	**72**	**50**	**28**	**100**	**100**	**72**	**83**	**89**	**67**
Impairment classification*	**MOD**	**MOD**	**SLI**	**MOD**	**MOD**	**NON**	**NON**	**SLI**	**NON**	**NON**	**SLI**
USE SUPPORT †	**PART**	**PART**	**PART**	**PART**	**PART**	**FULL**	**FULL**	**PART**	**FULL**	**FULL**	**PART**

* Impairment classifications: (NON) non-impaired, (SLI) slightly impaired, (MOD) moderately impaired, (SEV) severely impaired. See Table 3b.
† Use support designations: See Table 3a.

Five caddisfly taxa but only 10 "clinger" taxa were present in the sample; caddisflies were represented by low numbers. These findings suggest that sediment deposition may have compromised benthic habitats at this site. However, large numbers of *Optioservus* sp. may have affected the performance of both of these metrics. Since at least 30 taxa were supported at the site, it seems likely that instream habitats were diverse and available. Four stonefly taxa were collected; reach-scale habitat features were probably intact. The presence of 5 semivoltine taxa suggests that disasters such as dewatering or sediment pulses did not abort long life cycles here recently. The functional mix was overwhelmed by scrapers, another consequence of the abundance of *Optioservus* sp. in the sample. All other expected functional elements were, however, present in the sampled assemblage.

At the lower site on Rock Creek (ROCKC20), mayfly taxa richness (3) was lower than expected and the biotic index value (4.19) was higher than expected. Impairment of water quality is implied by these findings. Only 1 cold-stenotherm taxon was present in the collection, suggesting that water temperatures may have been warmer than typical of MVFP streams. Abundant midges (43% of sampled animals) and functional gatherers (60% of sampled animals) suggest that nutrient enrichment may further challenge benthic assemblage integrity.

Although 7 caddisfly taxa were collected, "clingers" were represented by only 11 taxa. Sediment deposition may limit access to stony benthic habitats to some extent. Other instream habitats were apparently diverse, however, since at least 32 taxa, 7 of which were predators, were supported at the site. Three stonefly taxa, somewhat fewer than expected, were among the sampled animals. Some disturbance of reach-scale habitat features, such as streambank stability, riparian zone integrity, or natural channel morphology may be associated with low stonefly richness. Four semivoltine taxa were present in the sample, including the perlid *Hesperoperla pacifica* and the caddisfly *Brachycentrus americanus*. These findings support the notion that surface flow persisted in this reach year-round, and that no catastrophic events interrupted long life cycles here. The functional composition of the sampled assemblage included all expected elements; gatherers were particularly abundant. This pattern may be associated with nutrient enrichment.

A single site on Kleinschmidt Creek (KLSMC01) was sampled. The biotic index value (3.17) calculated for the collected assemblage was within expected limits, but the mayfly taxa richness (5) was slightly lower than anticipated. Two cold-stenotherm taxa were present, but each was represented by very few individuals. Water temperature may have been slightly warmer than typical for an MVFP stream.

Seven caddisfly taxa and 17 "clinger" taxa imply benthic substrates free from fine sediment deposition. Other instream habitats were apparently diverse, since at least 34 taxa, including 7 predator taxa, were supported at the site. Reach-scale habitat features such as streambanks, riparian zones, and channel morphological elements may have suffered some disturbance, since only 2 stonefly taxa were collected. Semivoltine taxa were well-represented in the sample, implying that life cycles were not interrupted by dewatering, toxic inputs, or sediment pulses. Functionally, all expected components were present.

"Upper" Tributaries to Nevada Creek

Two sites on Washington Creek were sampled for this study. The upper site (WASHC10) supported a benthic assemblage characteristic of unimpaired streams. The low biotic index value (2.81) and high mayfly taxa richness (8) suggest excellent water quality. Five cold-stenotherm taxa were present, including the caddisfly *Apatania* sp. and the mayfly *Caudatella hystrix*. Cold, clean water is indicated.

It appeared to be unlikely that sediment deposition limited biotic health in this reach. Nine caddisfly taxa and 20 "clinger" taxa were collected, and the fauna included

taxa exquisitely sensitive to sediment deposition. These were *Arctopsyche grandis*, *Drunella doddsi*, and *Caudatella hystrix*. Together, these 3 taxa comprised 16% of the sampled assemblage. The sampled assemblage was diverse; at least 38 taxa were present at the site, including 9 predator taxa. These findings suggest that instream habitats were varied and available. Five stonefly taxa were collected. A rich stonefly fauna may be associated with undisturbed reach-scale habitat features. Long-lived animals were represented by 7 taxa, indicating that catastrophic dewatering or sediment pulses were not recent events here. The functional composition of the sampled assemblage included all expected elements in seemingly appropriate proportions. The abundant dipteran *Pericoma* sp. suggests carbonate parent materials in the watershed.

The assemblage collected at the lower site on Washington Creek (WASHC20) was dominated by non-insects, especially fingernail clams and amphipods (*Gammarus* sp.). The biotic index value (5.14) was much higher than expected for a foothill stream, and the number of mayfly taxa (5) collected at the site was somewhat lower than expected. Water quality was apparently impaired here, likely by nutrient enrichment. Since no cold-stenotherm taxa were collected, warm water temperatures cannot be ruled out.

Five caddisfly taxa and 13 "clinger" taxa were present in the sample. Both groups were slightly less rich than anticipated; sediment deposition may compromise benthic substrates to a mild extent. Since only 25 taxa were collected at this site, instream habitats may have been monotonous. Streambanks, riparian zones, and channel morphological features may have been essentially intact, since 4 stonefly taxa were among the sampled assemblage. Year-round surface flow was indicated by 4 long-lived taxa. It also seems unlikely that disasters such as toxic inputs or sediment pulses occurred here recently. All expected elements were present in the functional mix; shredders were particularly abundant, but this group included the abundant *Gammarus* sp.

Jefferson Creek was sampled for invertebrates in 3 locations. At the upstream site (JEFSC10), the sample yielded an assemblage that included fewer mayfly taxa (5) than expected, while the biotic index value (3.28) was within expected limits for a foothill stream. Snails (*Fossaria* sp.), leeches (*Helobdella stagnalis*), and an immature dragonfly (Gomphidae) nymph were collected along with the sensitive cold-stenotherm *Doroneuria* sp. This suggests that sampled habitats included both cold lotic environs as well as warmer near-lentic conditions. Water quality was probably good in this reach.

Nine caddisfly taxa and 14 "clinger" taxa were collected, implying that clean stony substrates were available for colonization. At least 34 taxa were supported at the site; 10 predator taxa were present in the sample. This may indicate a high diversity of instream habitats. Four stonefly taxa were among the sampled animals. Stonefly taxa richness may be associated with reach scale habitat features; it seems likely that streambanks, riparian zones, and natural channel morphology are indicated. Among the 6 semivoltine taxa collected here were 2 perlid stonefly taxa (*Hesperoperla pacifica* and *Doroneuria* sp.) and the caddisfly *Arctopsyche grandis*. Dewatering or other calamities that would interrupt long life cycles apparently did not affect this reach. All expected elements were present in the functional mix; shredders, especially the caddisfly *Lepidostoma* sp., were abundant, suggesting that riparian inputs of large organic debris were important energy sources here.

Upstream of Madison Gulch, Jefferson Creek (JEFSC20) supported a tolerant assemblage dominated by the elmid *Optioservus* sp. The biotic index value (4.61) exceeded expected limits for a foothill or valley stream, and mayfly taxa richness (4) was lower than anticipated. Nutrient enrichment seems the likely stressor in this reach, but warm water temperatures are also implicated by the presence of the dragonfly *Ophiogomphus* sp. and the caddisfly *Oecetis* sp., and by the general lack of cold-stenotherm taxa.

Caddisfly taxa were well-represented; 7 taxa were collected. Thirteen "clinger" taxa were present in the sample. These findings suggest that sediment deposition probably did not significantly impair stony substrates. The assemblage as a whole

exhibited diversity; at least 33 taxa were supported at the site. The predator fauna was also rich (10 taxa). Instream habitats were likely diverse. Reach scale habitat features may have been disturbed; only 3 stonefly taxa were collected. No fewer than 10 long-lived taxa were present at the site; these included the caddisfly *Arctopsyche grandis* and the perlid stonefly *Hesperoperla pacifica*. It seems unlikely that the reach was recently dewatered. All expected components were present in the functional mix, and proportions of contributing elements seemed appropriate.

While *Optioservus* sp. was abundant at the middle site on Jefferson Creek (JEFSC20), the numbers collected at the lowermost site (JEFSC30) were high enough to suggest that the gregarious behavior of these beetles resulted in a misrepresentation of their abundance at this site. Fifty percent of sampled animals at this site were *Optioservus* sp. The biotic index value (4.48) calculated for this assemblage was higher than expected. When *Optioservus* sp. is excluded from the calculation, the value falls to 3.96, which is also somewhat elevated compared to expectations. The number of mayfly taxa (3) was low. These findings suggest that water quality was degraded to some degree; nutrient enrichment cannot be ruled out. A single individual in a cold-stenotherm taxon was present, implying that water temperature was higher than typical for a foothill stream.

Nine caddisfly taxa and 13 "clinger" taxa were collected; sediment deposition probably did not limit access to hard benthic substrates here. Other types of instream habitat were apparently also available and diverse as well, since at least 35 taxa were present at the site. Ten of the collected taxa were predators. Streambanks, riparian zones, and other reach scale habitat features were likely undisturbed, since 4 stonefly taxa were present in the sample. The large number of semivoltine taxa (9) collected here implies that surface flow persisted year-round in this reach. The functional composition of the sampled assemblage was skewed toward scrapers, on account of the abundant *Optioservus* sp. in the sample. All other expected components were present. The impairment classification ("moderate") appears to exaggerate the condition of this site. *Optioservus* sp. is considered a tolerant taxon; its abundance in the sample results in a poor performance for the Percent Tolerant Taxa metric. Slight impairment and partial use support seems to be a more reasonable classification for this site.

Gallagher Creek upstream of its confluence with Nevada Creek (site GALGC10) yielded a sample with only 2 mayfly taxa present. Although the biotic index value (3.45) was within expected limits for a valley stream, the low mayfly taxa richness suggests that water quality may have been mildly impaired. Though scarce, there is other evidence to support this hypothesis. The tolerant dipteran *Ptychoptera* sp was common, and cold-stenotherms were represented by a single individual *Psychoglypha* sp. Elevated water temperature seems to be the most likely stressor.

Although there were fewer "clinger" taxa than expected, the site supported at least 11 caddisfly taxa. Stony substrate habitats were probably not obliterated by sediment deposition. The rich fauna (35 taxa) and ample number of predator taxa (9) collected at the site suggests that other instream habitats were also available and diverse. Since 4 stonefly taxa were present in the sample, it seems likely that reach scale habitat features such as riparian zone integrity, streambank stability, and natural channel morphologic elements were intact. Long-lived taxa (6) were well-represented, implying uninterrupted surface flow. All expected functional components were collected.

Two sites in Buffalo Gulch were sampled for this study. At the upstream site (BUFLG10), high mayfly taxa richness (6) and low biotic index value (2.46) suggest excellent water quality. Three cold-stenotherm taxa were collected here, including *Drunella doddsi* and *Drunella spinifera*. Cold, clean water apparently provided the matrix for the benthic assemblages in this reach.

Sixteen "clinger" taxa and 8 caddisfly taxa were present in the sample, suggesting that sediment deposition did not compromise hard substrate habitats. The rich predator fauna (10 taxa) and the high overall diversity of invertebrates collected here imply instream habitat complexity. Reach scale habitat features may have suffered

some disturbance, however, since stonefly taxa richness (3) was not as high as expected. Five long-lived taxa were taken in the sample; these included the elmid *Lara avara* and the caddisfly *Brachycentrus americanus*. The presence of these semivoltine taxa imply that life cycle interruptions such as dewatering, sediment pulses, or toxic inputs did not affect benthic assemblages in this reach. All expected functional components were present in apparently appropriate proportions. Abundant psychodid flies (*Pericoma* sp.) suggest that carbonaceous parent materials were present in this drainage.

Water quality apparently remained good in the lower reaches of Buffalo Gulch. At the downstream sampled site (BUFLG20), mayfly taxa richness (5) was somewhat lower than expected, although the biotic index value (3.25) was within expected limits. Three cold-stenotherm taxa were collected, including the caddisfly *Apatania* sp. and the perlid stonefly *Doroneuria* sp.

Eighteen "clinger" taxa and 9 caddisfly taxa were present in the sample, suggesting that sediment deposition did not appreciably limit the availability of stony habitats. At least 34 taxa were supported at the site, including 7 predator taxa; these findings imply complex and diverse instream habitats. The stonefly fauna included only 2 taxa. Low stonefly taxa richness may be associated with disturbance to reach scale habitat features such as streambanks, channel morphology, or riparian zones. Among the 6 long-lived taxa collected here were the caddisfly *Arctopsyche grandis* and the stonefly *Doroneuria* sp. In addition, elmid beetles were abundant. It seems unlikely that this reach was dewatered or experienced other catastrophes in the recent past. All expected components were present in the functional mix.

A single site on Braziel Creek (BRZLC10) was sampled. The assemblage collected here produced a biotic index value of 1.91, suggesting excellent water quality. Mayfly taxa richness (5) was somewhat depressed compared to expectations for a valley stream site, but 3 sensitive cold-stenotherm taxa were present, including the caddisfly *Apatania* sp. and the mayfly *Drunella doddsi*. Given the site location near the mouth of the stream, these findings appear to indicate that water quality was essentially unimpaired at this site.

The sampled assemblage included 13 "clinger" taxa, which is slightly fewer than expected. However, 9 caddisfly taxa were present in the sample. Hard benthic substrate habitats were probably not significantly impaired by sediment deposition. Taxa richness (28) was low compared to the other sites studied here, suggesting that instream habitats may have been limited. Only 3 stonefly taxa were collected; reach scale habitat elements may have been disturbed to some extent. Five long-lived taxa, including the elmid *Lara avara* and the caddisfly *Brachycentrus americanus* were present at the site; year-round surface flow is implied. The functional composition of the assemblage included all expected groups; shredders were particularly abundant, suggesting ample riparian inputs of large organic material and hydrologic conditions favoring its retention.

Douglas Creek and its tributaries

Despite prolonged sampling effort, the site at Black Bear Creek (BKBRC10) yielded a sample with only 149 organisms, too few to produce reliable bioassessment results. Low numbers of invertebrates at a site may clearly indicate impairment. A few observations on the taxonomic composition of the collected animals are cautiously offered. The amphipod *Gammarus* sp. was abundant in the sample, suggesting poor water quality. Immature tubificid worms and tolerant midges (*Polypedilum* sp. and *Odontomesa* sp.) suggest nutrient enrichment and/or warm water temperatures.

Two sites on Murray Creek were sampled for invertebrates. At the upstream site (MURYC10), the benthic assemblage suggests excellent water quality and undisturbed habitat. The biotic index value (2.90) is within expected limits, and the mayfly fauna was rich (8 taxa). Among the 4 cold-stenotherm taxa present in the sample were the

sensitive mayflies *Drunella doddsi* and *Drunella spinifera*, as well as the stonefly *Despaxia augusta*. Cold, clean water is indicated.

Thirteen "clinger" taxa and 5 caddisfly taxa were collected, and several taxa sensitive to sediment deposition were also present. These include the stonefly *Doroneuria* sp., and the mayfly *Drunella doddsi*. These findings support the notion that stony substrate habitats were free of contamination by sediment deposition. The rich fauna (33 taxa) and numerous predator taxa (12) imply complex and undisturbed instream habitats. At least 5 stonefly taxa were supported at the site; high stonefly diversity may be associated with intact reach scale habitat features. Thus it seems likely that stable streambanks, functional riparian zones, and natural channel morphology characterized this reach. Four semivoltine taxa were collected, implying that surface flow persisted year-round here. The functional composition of the sample included all expected elements; gatherers were the most abundant group. The common occurrence of *Pericoma* sp. could be associated with carbonate influences in the watershed.

The sample collected at the downstream site (MURYC20) was dominated by non-insects and tolerant midges. The biotic index value was 6.27, the highest value reported in this study. A single individual mayfly was collected, and no cold-stenotherms appeared. These signals strongly suggest that water quality was impaired by nutrients and/or thermal stressors.

Both "clingers" and caddisflies were scarce in the sample taken here. Sediment deposition may have limited the availability of stony benthic habitats. Overall taxa richness (29) was low which could be related to monotonous instream habitats. Reach scale habitat features may have suffered disturbance; the sample yielded only 2 stonefly taxa and neither was abundant. Five semivoltine taxa were collected, suggesting that the site was not recently dewatered. Gatherers overwhelmed the functional composition of the assemblage; this pattern is consistent with water quality disturbance.

Douglas Creek was sampled for invertebrates at 3 sites. Evidence of water quality degradation and habitat disturbances could be discerned from samples at all 3 sites. Sampling efforts at the uppermost site (DOUGC10) intercepted numerous *Optioservus* sp. (53% of sampled animals). Due to the gregarious nature of this beetle, its actual abundance at the site may have been overrepresented; this could result in a skewing of metric performance and unreliable bioassessment.

The high biotic index value (4.87) suggests impairment by nutrient enrichment and/or warm water temperatures. Removing *Optioservus* sp. from the biotic index calculation results in a similar value (4.71). The mayfly taxa richness (2) was low, strengthening the hypothesis that significant water quality degradation characterized this reach. Not a single cold-stenotherm or sensitive taxon was taken in the sample. The presence of the isopod *Caecidotea* sp. and the caddisfly *Helicopsyche borealis* strongly suggest that warm temperatures limited the biotic assemblage here.

Ten "clinger" taxa and 2 caddisfly taxa were present in the sample. Both groups are poorly represented; these findings could indicate that sediment deposition contaminated hard benthic substrate habitats. Low taxa richness (28) and few predator taxa (4) suggest that instream habitats lacked diversity and complexity. Three stonefly taxa were collected, and none was abundant. Poor richness in this group can be associated with disturbance to reach scale habitat features such as streambanks, riparian zones, and channel morphological elements. Long-lived taxa at this site were mostly represented by elmids; there were four such taxa present. Recent dewatering seems unlikely. Scrapers dominated the functional mix, consistent with the plethora of *Optioservus* sp. Filterers were notably scarce here.

At the middle site (DOUGC20), poor water quality was indicated by the high biotic index value (5.83) and the low mayfly taxa richness (2). Abundant amphipods (*Hyalella* sp. and *Gammarus* sp.), isopods (*Caecidotea* sp.), and other warm water indicator taxa (*Cheumatopsyche* sp. and *Helicopsyche borealis*) support a hypothesis that thermal stressors limited biotic assemblages here. Nutrient enrichment may

further impair water quality here; filter-feeders and tolerant taxa comprised a large proportion of the benthic assemblage.

Sediment deposition appears to have been less of a problem at this site, compared to the other 2 Douglas Creek locations. Fourteen "clinger" taxa and 6 caddisfly taxa were collected, suggesting that stony substrates were available for colonization. Overall taxa richness (36) was high here; a diverse fauna may indicate diverse and complex instream habitats. The sample did not contain any stoneflies; reach scale habitat features may be disturbed. Four semivoltine taxa appeared, making it seem unlikely that dewatering occurred recently. The functional composition of the sampled assemblage included all expected groups.

The lowermost site on Douglas Creek (DOUGC30) yielded the least diverse assemblage at any site in this study. Three tolerant taxa dominated the assemblage: *Hydropsyche* sp., *Optioservus* sp., and *Cheumatopsyche* sp. Together, these animals made up 83% of the sampled fauna. The biotic index value (4.67) reflected the tolerant nature of the entire assemblage. Only 2 mayfly taxa were collected. These findings strongly suggest that nutrient enrichment affected the invertebrate community at this site. No cold-stenotherms were present in the sample, and many taxa collected here prefer warm water. Among these are *Helicopsyche borealis* as well as *Cheumatopsyche* sp. Thermal stress and nutrient enrichment are likely to have characterized this reach of Douglas Creek.

Evidence that sediment deposition limited instream habitats could be discerned in the fauna: only 6 "clinger" taxa and 3 caddisfly taxa appeared in the sample. Other types of habitats may also have been disturbed, since only 17 taxa were found here. Reach scale habitat features may have been in better condition here than at the other 2 Douglas Creek sites, since 4 stonefly taxa were present. Only 3 long-lived taxa were collected; recent dewatering cannot be ruled out. Consistent with the theory of nutrient enrichment, filter-feeders dominated the functional mix.

"Lower" tributaries to Nevada Creek

A single sample was collected from Yourname Creek (YRNMC20). This site yielded a sample containing only 4 mayfly taxa, fewer than expected. The biotic index value (3.89) was within expected limits for a valley stream site. Taxonomic characteristics of the sampled assemblage suggest that this site may be transitional; a few individuals in highly tolerant taxa characteristic of warm water environs (e.g. *Cheumatopsyche* sp., *Parapsyche almota*, others) were collected along with a few individuals in taxa typically associated with cold, montane locales (e.g. *Parapsyche elsis*, *Apatania* sp., others). There is no evidence of severe pollution, but some thermal stress may be present.

Sixteen "clinger" taxa and 8 caddisfly taxa suggest that sediment deposition did not appreciably limit access to stony substrate habitats. Overall taxa richness (40) was high and perhaps related to complex instream habitats and the apparently varying thermal conditions within the sampled reach. Only 3 stonefly taxa were collected; low stonefly richness may indicate impairment of reach scale habitat features. Long-lived taxa (6) were amply represented, precluding the possibility that dewatering, toxic inputs, or scouring sediment pulses recently affected the reach. Among the functional elements, shredders were notably abundant, implying that large organic material was abundantly contributed from riparian sources, and that hydrologic conditions at the site favored retention of such material. All other expected functional components were present here as well.

Wales Creek (WALSC10) was sampled at a single site. Warm water temperatures appear to be indicated by the taxonomic composition of the assemblage collected there. The biotic index value (4.09) was elevated compared to expectations for a valley stream, and the sample included fewer mayfly taxa (4) than anticipated. No sensitive or cold-stenotherm taxa appeared in the sample, but the lymnaeid snail *Stagnicola* sp., which prefers warmer water, was common.

Ten "clinger" taxa and 6 caddisfly taxa were collected. While the caddisfly taxa richness was within expectations, there were fewer "clinger" taxa than anticipated. Contamination of benthic surfaces by sediment deposition cannot be ruled out. Instream habitats may have been diverse despite sediment deposition, since at least 31 taxa were supported at the site; ten of these were predators. Only 3 stonefly taxa appeared in the sample, suggesting that reach scale habitat features may have suffered some disturbance. All 5 of the semivoltine taxa collected here were elmid beetles. It seems unlikely that this reach of Wales Creek has been dewatered in the recent past. The functional composition of the sample contained all expected feeding groups. Notable was the abundance of shredders, which implies the presence of large organic debris, likely of riparian origin. Hydrologic conditions and channel morphology likely promoted retention of such material.

A single mayfly taxon (*Ephemerella inermis*) was taken in the sample collected at the Frazier Creek site (FRZRC10). The biotic index value (3.46), however, was not elevated compared to expectations for a valley stream site. The turbellarian *Polycelis coronata* dominated the sample; these animals accounted for 34% of the sampled assemblage, and account for the low biotic index score. If the turbellarian is omitted from the biotic index calculation, the resulting value (4.75) is higher than expected. *P. coronata* may be associated with groundwater inputs in gaining parts of streams. Despite the likelihood of groundwater contributions, it seems likely that thermal stress affected the benthic assemblage in this reach. Warm water preference is exhibited by the caddisfly *Cheumatopsyche* sp. and by the leech *Mooreobdella* sp., both of which were present here. Nutrient enrichment cannot be ruled out.

Ten "clinger" taxa and 4 caddisfly taxa were present in the sample, suggesting that sediment deposition may have been an additional challenge to biotic integrity at this site. Only 26 taxa were collected; instream habitats may have been limited or monotonous. No stoneflies were taken; this finding could indicate that streambanks, riparian zones, or other reach scale habitat elements were disturbed. There were five long-lived taxa in the sample; all were elmid beetles. Dewatering or other catastrophic interruptions of semivoltine life cycles seem to have spared this reach of Frazier Creek in the recent past. The large contribution of omnivores to the functional composition of the sampled assemblage is accounted for by the abundance of *Polycelis coronata*; some experts consider this beast a predator. All expected feeding groups were present in the sample.

Monture Creek

Three sites on Monture Creek were sampled for invertebrates. Mayflies in 8 taxa dominated the uppermost site (MONTC10); notable among these was the abundant *Drunella doddsi*, a sensitive cold-stenotherm. The biotic index value (1.78) was low. At least 7 sensitive taxa, among them 6 cold-stenotherms, were collected here. These findings suggest that cold, clean water characterized this site.

Caddisflies were represented by a single taxon, and the richness of the "clinger" fauna was depressed, compared to expectations for a montane stream. The possibility that sediment deposition limited benthic habitat availability cannot be ruled out. However, the abundance of *Drunella doddsi*, which has been demonstrated to be limited to sites with less than 30% fine sediment, appears to contradict that hypothesis. On the other hand, low taxa richness (24) may support the notion that instream habitats were simplified, perhaps by sediments. Stoneflies were well-represented; 5 taxa appeared in the sample. A rich stonefly fauna could be associated with intact riparian zones, stable streambanks, and natural channel morphology. Only 2 long-lived taxa were collected. This finding could indicate that recent dewatering, sediment pulses, or other catastrophes may have interrupted semivoltine life cycles recently. All expected functional components were present at the site, but shredders seemed less prominent among the feeding groups than typical of headwater environs. Perhaps riparian inputs

of large organic debris were limited, or hydrologic conditions did not contribute to the retention of such material.

At the middle site, excellent water quality was indicated by high mayfly taxa richness (7) and by the low biotic index value (1.95). Only one cold-stenotherm taxon (*Drunella doddsi*) was collected, and only a single individual represented the species. Water temperatures may not have been as cold as expected for a valley site.

Both "clingers" (18 taxa) and caddisflies (7 taxa) were well-represented, implying clean benthic stones free from sediment deposition. Taxa richness (29), however, was not as high as anticipated, which could indicate some monotony of instream habitats. The stonefly fauna was also depauperate; only 2 taxa were collected and neither taxon was abundant. Low stonefly richness could be associated with disturbed reach scale habitat features such as streambanks, channel morphology, or riparian zones. The fact that scrapers were the dominant functional group, making up 52% of sampled animals, suggests that riparian shading may have been limited. All other expected feeding groups were present. Semivoltine taxa were well-represented, making it seem unlikely that disastrous loss of surface flow, scouring sediment pulses, or toxic inputs were among recent events in this reach.

Water quality apparently diminished in the lower reaches of Monture Creek. At the downstream site (MONTC30), only 3 mayfly taxa were collected in the sample, and the biotic index value was high (5.38). The dominant taxon was a naiad worm (*Nais* sp.), and moderately tolerant midges were abundant. A single cold-stenotherm was present. These findings suggest that nutrient enrichment and thermal stress may have limited benthic assemblage integrity in this reach.

Nine caddisfly taxa and 16 "clinger" taxa were counted, suggesting that sediment deposition did not appreciably limit availability of stony benthic habitats. Taxa richness (30) was within expected limits; instream habitats were likely diverse and complex. Few stoneflies were present in the sample, and only 2 taxa were represented. Reach scale habitat features may have been disturbed. At least 6 long-lived taxa were present at the site, including the caddisfly *Arctopsyche grandis*. Surface flow probably persisted year-round in this reach. The functional composition of the benthic assemblage included all expected elements in seemingly appropriate proportions.

Clearwater River tributaries

The sampled site on Richmond Creek (RHMDC01) supported a sensitive, diverse, and functional benthic assemblage characteristic of minimally impaired montane streams. The low biotic index (2.29), high mayfly taxa richness (9) and rich cold-stenotherm fauna (13 taxa) strongly suggest that cold, clean water provided the matrix for the rich assemblage represented in the sample collected here. Among the 15 sensitive taxa present in the sample were the stoneflies *Visoka cataractae, Yoraperla brevis,* and *Megarcys* sp., and the caddisfly *Neothremma* sp. The turbellarian Polycelis coronata was common, suggesting that groundwater influenced flow here.

At least twenty "clinger" taxa and 10 caddisfly taxa were resident in this reach. Excess sediment deposition seems highly unlikely. The site supported the richest fauna of any studied location; 50 taxa appeared in the sample. Instream habitat complexity and quality were likely high. Reach scale habitat features were probably intact, since 8 stonefly taxa were collected. Among the 3 semivoltine taxa present were the caddisfly *Parapsyche elsis* and the perlid stonefly *Doroneuria* sp. Catastrophic events such as dewatering or scouring sediment pulses were unlikely. The functional mix included all expected components in apparently appropriate proportions.

Two sites on the West Fork Clearwater River were sampled for invertebrates. The upper site (CLRWF10) yielded a sample with organisms typical of an undisturbed montane stream. Ten cold-stenotherm taxa made up 35% of sampled animals and included the mayflies *Drunella spinifera* and *Baetis bicaudatus*. The low biotic index value (1.85) and high mayfly taxa richness (9) indicate that water quality was probably excellent here. The site was apparently characterized by cold, clean water.

No fewer than 25 "clinger" taxa and 12 caddisfly taxa were resident here. These findings strongly suggest that sediment deposition did not impair benthic substrate habitats. Overall taxa richness (47) was high, and 20 predator taxa were counted; a diversity of instream habitats were likely present and available. Since 6 stonefly taxa were taken, it seems probable that reach scale habitat features such as streambanks, riparian zones, and channel morphologic elements were undisturbed. Among the 8 semivoltine taxa collected here were the caddisflies *Brachycentrus americanus* and *Parapsyche elsis*. The presence of these long-lived fauna imply that catastrophes such as dewatering, scouring sediment pulses, or toxic contamination were not likely to have been among recent events in this reach. The functional composition of the sampled assemblage included all expected components, in proportions that seemed appropriate for a montane stream site.

High quality habitat and water appear to have persisted at the lower sampled site on the West Fork Clearwater River (CLRWF20). High mayfly taxa richness (9), a biotic index value (3.09) within expected limits for a foothill stream, and a rich cold-stenotherm fauna (6 taxa) suggest that water temperatures were cold, and that no pollutants challenged the invertebrate assemblages. Among the sensitive taxa collected here were the perlodid stonefly *Cultus* sp. and the nemourid *Visoka cataractae*.

Both "clingers" (25 taxa) and caddisflies (11 taxa) were represented by a rich assortment of taxa. High diversity of these groups is associated with stony substrates free from sediment deposition. High overall diversity of invertebrate taxa (47) suggests that instream habitat complexity was appropriate for an undisturbed stream. At least 8 stonefly taxa were present at the sampled site; this finding may be associated with intact habitat features at the reach scale. Ten long-lived taxa were collected, making it seem likely that surface flow persisted year round in this reach. The functional composition of the invertebrate assemblage included all expected elements.

Deer Creek was sampled at 2 sites. At both sites, invertebrate assemblages indicated excellent water quality and undisturbed instream and reach scale habitats. The high mayfly taxa richness (9) and low biotic index value (2.58) at the upstream site (DEERC10) clearly suggest that neither nutrient enrichment nor thermal stresses affected biota here. Eleven cold-stenotherm taxa, including the mayfly *Caudatella hystrix* and the caddisfly *Dolophilodes* sp. were collected here. These findings imply that water quality and thermal regimes were appropriate here.

Seventeen "clinger" taxa and 6 caddisfly taxa were taken in the sample. Sediment deposition was likely not a limiting factor to invertebrates at this site. Overall taxa richness (37) was high and the predator fauna (10 taxa) was diverse, suggesting that instream habitats were diverse and complex. Stonefly taxa richness (5), an indicator of the quality of reach scale habitat features, was within expectations for a site with little disturbance to riparian zones or channel morphology. There were 5 long-lived taxa in the sample; it seems unlikely that the site was recently dewatered or subject to scouring sediment pulses. All expected functional components, in appropriate proportions, were present in the mix of feeding groups collected here.

At the downstream site (DEERC20), the rich mayfly fauna (10 taxa) included sensitive cold-stenotherms such as *Caudatella hystrix* and *Drunella doddsi*. The high sensitivity of the assemblage as a whole is reflected in the low biotic index value (2.65). Cold, clean water is indicated.

Twenty-three "clinger" taxa and 9 caddisfly taxa were collected; high richness in these groups is associated with clean stony substrates free from sediment deposition. Diverse and undisturbed instream habitats are suggested by the large number of taxa (45) present in the sample, as well as by the large number of predator taxa (11) taken. At least 6 stonefly taxa were resident at the site, implying that reach scale habitat features such as streambanks, riparian zones, and channel morphologic features were probably intact. Seven semivoltine taxa appeared among sampled organisms; catastrophes which would abort their long life cycles were probably not among recent

events in this reach. The functional mix contained all expected components and the proportional representation of each seemed appropriate.

A single site on Blanchard Creek (BLHDC10) was sampled. The benthic organisms collected here included only 3 mayfly taxa, but the biotic index value (3.43) was within expected limits for a foothill stream. Since 4 sensitive cold-stenotherm taxa appeared in the sample, it seems likely that water quality was good, and temperatures cold.

Nine caddisfly taxa and 15 "clinger" taxa were collected, suggesting that sediment deposition did not limit access to stony substrate habitats here. Overall taxa richness (30) indicated that diverse instream habitats were probably available. Reach scale habitat features were likely intact, since 4 stonefly taxa were present in the sample. Long-lived taxa (5) were well-represented and indicated that dewatering or other disasters have not recently interrupted life cycles in this reach. The functional composition included all expected elements; the abundance of shredders was notable. This group made up 48% of sampled animals and included 7 taxa. Riparian inputs of large organic material were probably ample, and channel complexity and hydrologic regimes likely favored retention of such material.

CONCLUSIONS

- Seven Up Pete Creek (SVNPC01) supported a sensitive, diverse, and functional assemblage characteristic of minimally impaired montane streams.
- The sample collected at the upper site on Rock Creek (ROCKC10) was overwhelmed by the gregarious taxon *Optioservus* sp. Its abundance skewed the performance of many metric expressions of assemblage tolerance and function, and rendered bioassessment unreliable. At the lower site (ROCKC20), evidence of nutrient enrichment and sediment deposition could be discerned from the taxonomic and functional composition of the assemblage.
- Kleinschmidt Creek (KLSMC01) supported an assemblage that suggested slightly warmer water temperatures than anticipated.
- The upper site on Washington Creek (WASHC10) yielded a sample containing a sensitive, diverse assemblage that suggested minimal impairment of water quality and habitat. The downstream site (WASHC20) supported a tolerant assemblage; non-insects were dominant here. Nutrient enrichment seems likely in this reach.
- Water quality conditions worsen from excellent at the uppermost site in Jefferson Creek (JEFSC10) to apparent degradation from nutrient enrichment and elevated temperatures at the middle and lower sites (JEFSC20 and JEFSC30). Assessment at the lower site is complicated by the abundance of the gregarious taxon *Optioservus* sp. Although scores imply moderate impairment, this appears to be exaggerated, given the taxonomic and functional composition of the sampled assemblage.
- Water temperatures may have been elevated at the sampled site on Gallagher Creek (GALGC10), but instream and reach scale habitat features were likely intact.
- Both sampled sites in Buffalo Gulch (BUFLG10 and BUFLG20) yielded diverse invertebrate assemblages indicating good water quality and undisturbed instream habitats. Low stonefly taxa richness may have been associated with disturbance to reach scale habitat features in both sampled reaches.
- Near its mouth, Braziel Creek (BRZLC10) supported a less diverse assemblage than other sites studied. While water quality indicators suggested clean water

and cold temperatures, instream and reach scale habitats may have been slightly disturbed.

- The sample collected at Black Bear Creek (BKBRC10) contained too few organisms for reliable bioassessment. The taxonomic composition of the small sample suggested impaired water quality.
- Murray Creek exhibited a diminishment of both water quality and habitat integrity from the upstream site (MURYC10), where the benthic assemblage suggested excellent conditions, to the lower site (MURYC20) where there was evidence of both water quality degradation and habitat disturbances.
- Invertebrate assemblages collected from 3 sites on Douglas Creek suggested that water quality was affected by nutrient enrichment and thermal stress in all sampled reaches. Sediment deposition may have limited instream habitats at the uppermost site (DOUGC10) and the lowermost site (DOUGC30), while the middle site (DOUGC20) apparently supported no stoneflies and may have exhibited disturbance to reach scale habitat features.
- Warm water temperatures likely stressed the benthic assemblage at Yourname Creek (YRNMC20).
- Evidence of sediment deposition and warmer than expected water temperatures could be discerned from analysis of the invertebrate assemblage collected from Wales Creek (WALSC10).
- The sampled site on Frazier Creek (FRZRC10) appeared to suffer from impaired water quality, likely due to elevated temperatures and perhaps also nutrient enrichment. Sediment deposition likely limited instream habitats, and disturbance to reach scale habitat features appeared to further insult benthic assemblages.
- Sediment deposition may have limited instream habitats at the upstream site on Monture Creek (MONTC10). Unpolluted water appeared to characterize the middle site on Monture Creek (MONTC20), but the lack of cold-stenotherm taxa, the preponderance of scrapers, and the depauperate stonefly fauna at this site suggest that riparian canopy was limited here. Water quality was likely impaired by nutrient enrichment and thermal stress at the lowermost site (MONTC30).
- The sampled site on Richmond Creek (RHMDC01) supported a rich, sensitive, and functional benthic invertebrate assemblage typical of near-pristine mountain streams.
- The "slight impairment" reported at the lower site on the West Fork Clearwater River (CLRWF20) appears to underestimate the quality of the invertebrate assemblage collected there. Taxonomic, tolerance, and functional analysis of the sample indicates a fauna appropriate to a non-impaired montane site. Excellent habitat and water quality were likely at the upstream site (CLRWF10), where a diverse, sensitive, and functional assemblage was sampled.
- Undisturbed habitats and cold, clean water appear to characterize both sampled sites on Deer Creek (DEERC10 and DEERC20).
- Benthic assemblage composition may indicate good water quality and intact habitats at the sampled site on Blanchard Creek (BLHDC10).

Ordination studies

To summarize similarities between invertebrate assemblages in this study, a sites-by-taxa matrix was constructed, using the relative abundance of each taxon at each site. Principal Components Analysis (PCA) was used to generate graphical ordinations of the data. Ordination produces a plot in which similar assemblages are graphed close together, and dissimilar assemblages are far apart. Figures 3 and 4 give the results of the PCA.

Figure 3 illustrates the ordination of all 40 invertebrate assemblages. Most sites cluster in the upper left of the plot, while clear outliers (BKBRC10, CLRWF10, RHMDC01, SVNPC01, and DOUGC20) fall outside the cluster. Symbols representing assemblages collected at Black Bear Creek (BKBRC10) and the middle site on Douglas Creek (DOUGC20) are arrayed along the length of Axis 2. Black Bear Creek was taxonomically similar to the clustered sites in many ways, but the sample collected there had few organisms. The symbol for the middle site on Douglas Creek is positioned on the plot so as to suggest that its invertebrate assemblage may have been unique among the studied sites. The assemblage collected there strongly suggests warm water temperatures and nutrient enrichment; the site was among the most impaired sites studied here. Dominated by *Cheumatopsyche* sp., the assemblage had disproportionate numbers of aquatic mites, isopods, and amphipods.

Figure 3. Ordination (PCA) of aquatic invertebrate assemblages collected at 31 sites in the Blackfoot River watershed, September – October 2003.

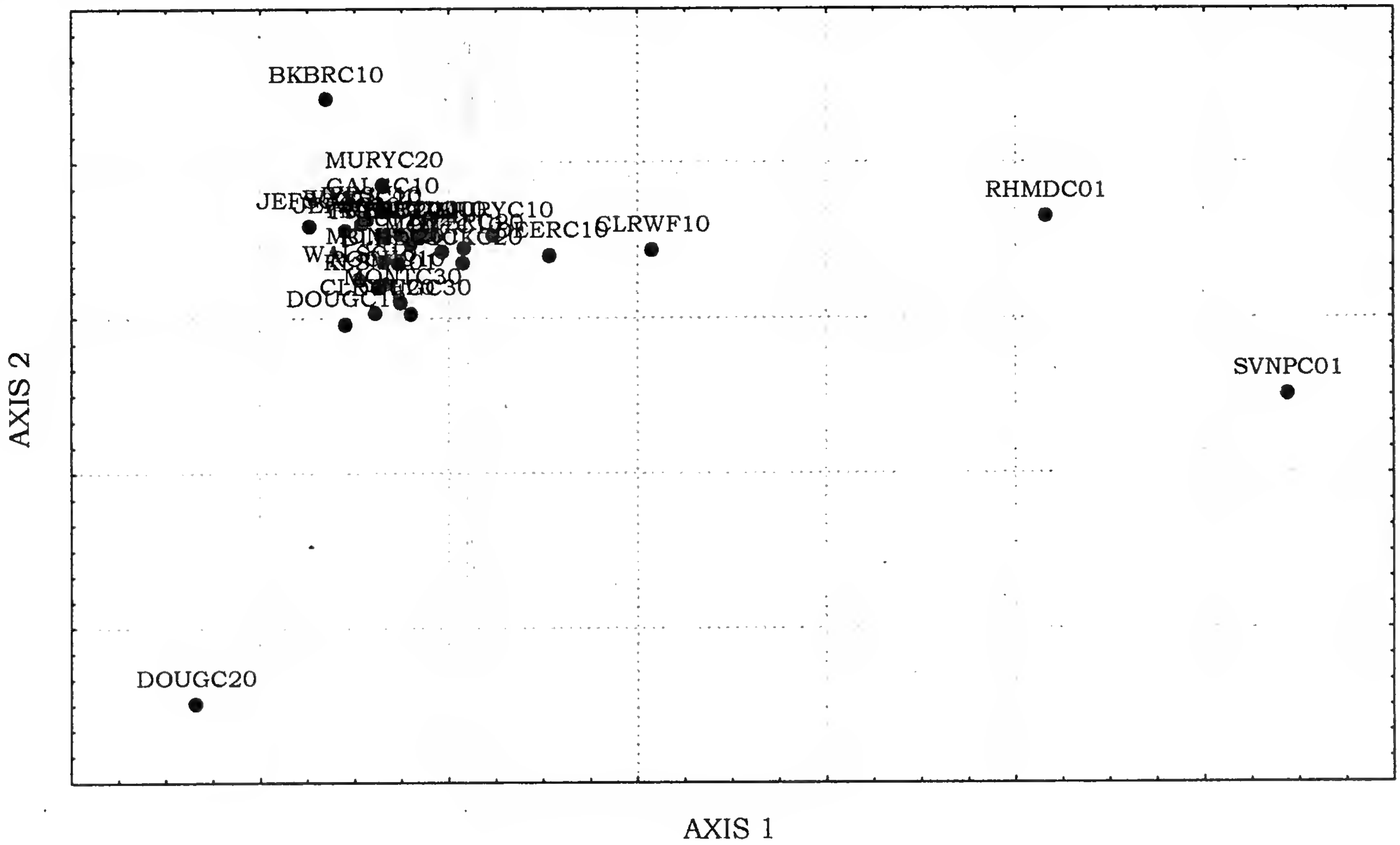
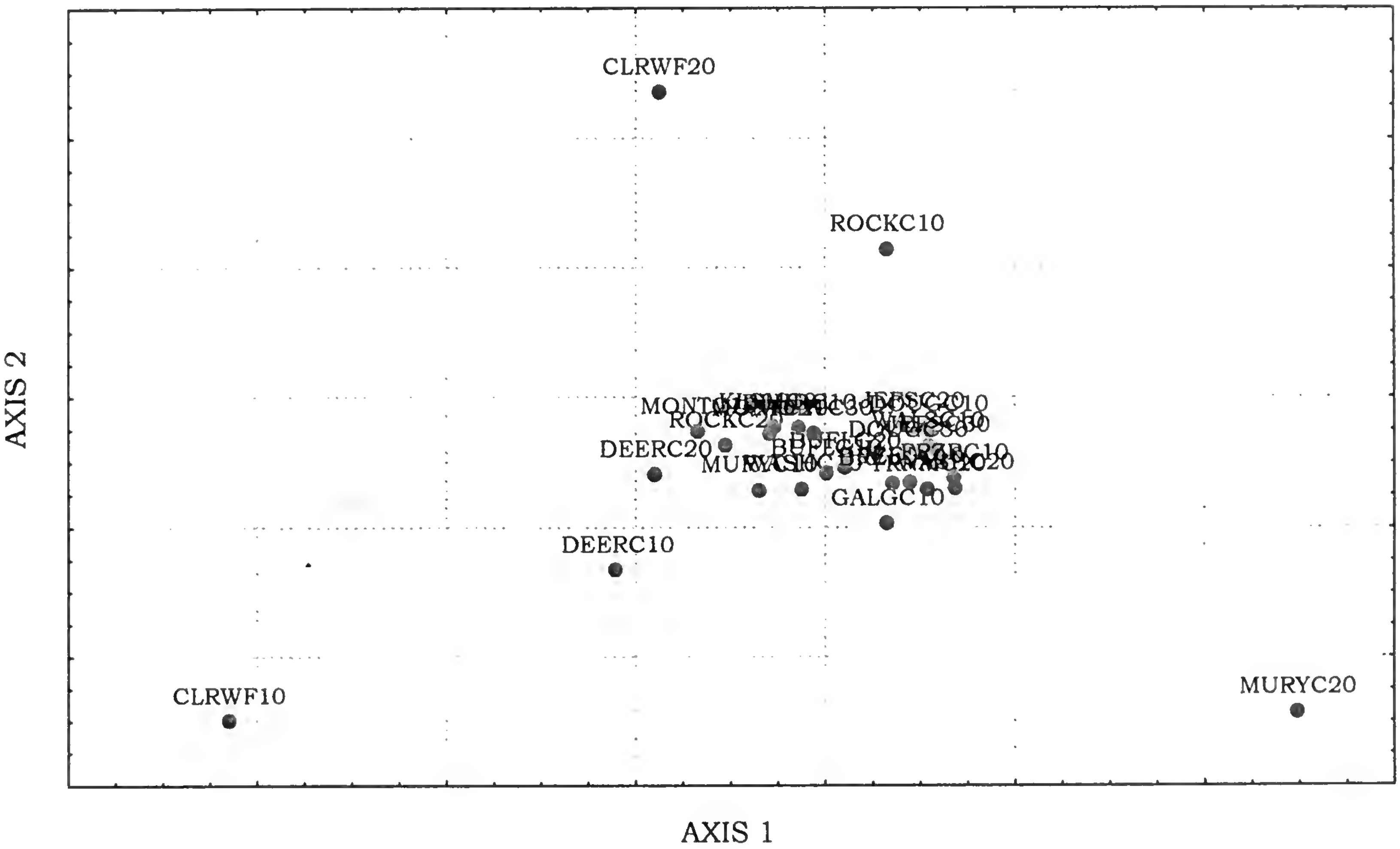


Figure 4. Ordination of aquatic invertebrate assemblages from 27 sites in the Blackfoot River watershed, September-October 2003. Four outliers were removed.



While many invertebrate taxa were nearly ubiquitous among sampled sites, sites clustering in Figure 3 tended to support taxa such as *Apatania* sp., *Arctopsyche grandis, Brachycentrus americanus, Cricotopus (Cricotopus)* spp., *Drunella grandis, Glossosoma* sp., *Hesperoperla pacifica, Hydropsyche* sp., the Lepidostoma Pluviale Group, *Optioservus* sp., *Pericoma* sp., Physidae, Pisidiidae, *Simulium* sp. and *Zaitzevia* sp. All of these taxa were either unique to the clustered group of sites and commonly encountered in samples from this group, or very rare in the outlier sites of Figure 3. These animals suggest cool-but-not-cold water temperatures, fair-to-good water quality, moderately open riparian canopy, and fairly clean substrates. *Pericoma* sp. was common at many of these sites; where it was abundant, it may have been associated with carbonaceous parent materials in the drainage.

Several taxa characterized the outlying sites of Figure 3. Unique to these sites, or common there and rare elsewhere were the following taxa: *Ameletus* sp., *Baetis bicaudatus, Drunella spinifera, Neothremma* sp., *Parapsyche elsis, Visoka cataractae,* and *Zapada coloradensis.* These are taxa typically associated with cold water and excellent water quality. *Pericoma* sp. was uncommon among this group of sites, suggesting a weaker carbonate influence in these drainages or reaches. Thus Axis 1 in Figure 3 appears to be associated with water temperature, with warmer sites clustered on the left side of the plot, and colder sites arrayed out and to the right of the cluster.

Removing outlying sites and re-running the ordination study often elucidates more subtle patterns in the biological assemblages. Figure 4 is a plot constructed from the PCA of all but 4 of the sites used in Figure 3. Extreme outliers were deleted from the data, leaving 27 sites in the ordination. A tight cluster of the majority of sites remains; it is located in the center of the plot in Figure 4. Outliers in this plot are CLRWF10, CLRWF20, ROCKC10, and MURYC20. The assemblage collected from Murray Creek at the lower site (MURYC20) shared many taxonomic similarities with the majority of sampled sites, but was dominated by disproportionate numbers of immature tubificid worms and moderately tolerant midges. The highest biotic index score of any site in this study was calculated for the assemblage collected here, and sediment indicators suggested severe deposition at this site. In contrast, the same indicators suggested exquisitely clean benthic substrates at the upper site on the West Fork Clearwater River (CLRWF10); both the "clinger" taxa richness metric and the caddisfly taxa richness metric returned values among the highest calculated for sites in this study. Notably, symbols representing these two sites are located at opposite ends of Axis 1 in Figure 4, suggesting that assemblage variability along this axis may be related to the performance of sediment metrics.

The other outlying sites of Figure 4 (CLRWF20 and ROCKC10) resemble the coldwater outliers of Figure 3, but appear to be characterized by somewhat moderated water temperatures. For example, some taxa common to the Figure 3 outliers were not collected at any Figure 4 outlier sites; these were: *Visoka cataractae* and *Neothremma* sp. These taxa are typically found in cold water. On the other hand, Figure 4 outliers included taxa that were not found at any Figure 3 outlier site, including *Zaitzevia* sp., *Optioservus* sp., and *Cricotopus (Cricotopus)* spp. These taxa are typically not found at sites with the coldest water; they prefer warmer environs. These findings suggest that the Figure 4 outliers may be transitional in temperature, that is, they are warmer than the Figure 3 outliers, but colder than the Figure 3 clustered sites. Another interesting phenomenon is the apparent replacement of *Doroneuria* sp., which occurred at all sites except the Figure 4 outliers by *Claassenia sabulosa*, which occurred at no sites except the Figure 4 outlier sites.

Habitat Assessment

Figures 5a and 5b graphically compare total habitat assessment scores recorded for the 31 sites in this study. Tables 5a through 5d show the habitat parameters evaluated, parameter scores and overall habitat evaluations for the sites studied. Habitat conditions ranged from optimal at 13 studied sites to marginal at 5 sites. The 13 remaining sites were appraised as sub-optimal.

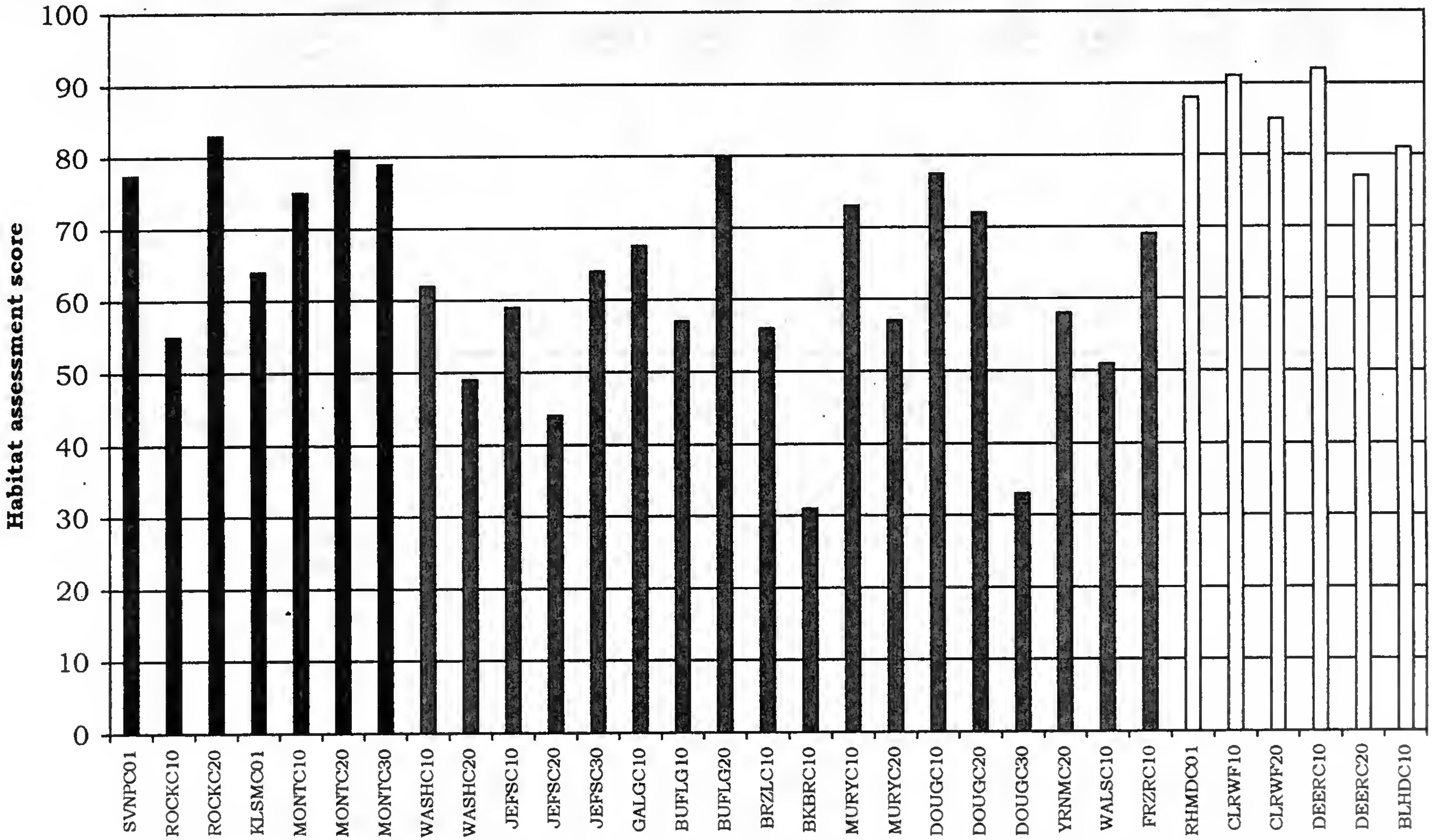
Field personnel judged instream, channel, streambank, and riparian habitat conditions to be optimal at the site on Seven Up Pete Creek (SVNPC01), the lower site on Rock Creek (ROCKC20), all 3 visited sites on Monture Creek (MONTC10, MONTC20, and MONTC30), the lower site in Buffalo Gulch (BUFLG20), the upper site on Douglas Creek (DOUGC10), the site on Richmond Creek (RHMDC01), both visited sites on Deer Creek (DEERC10 and DEERC20), and the site on Blanchard Creek (BLHDC10).

At the upper site on Rock Creek (ROCKC10), moderate sediment deposition and monotonous benthic substrate were noted. The riparian zone was judged to be abbreviated, and channel flow status was appraised as marginal. Habitat conditions at Kleinschmidt Creek were rated sub-optimal due to perceived sediment deposition, and limited riparian vegetation.

In the upper Nevada Creek watershed, all sites were judged to have foreshortened riparian zones. Channel alteration and disturbed streambank vegetation were noted at the upper site on Washington Creek (WASHC10). At the lower site (WASHC20), sediment deposition was judged to be severe. Embedded, monotonous substrates were recorded, and the channel flow status was appraised as marginal. The upper site on Jefferson Creek (JEFSC10) was reported to have moderately unstable streambanks and disturbed bank vegetation. At the middle site (JEFSC20), investigators reported moderate sediment deposition, embedded substrates, and marginal benthic habitat conditions. At the lower site (JEFSC30), moderate sediment deposition was noted. Gallagher Creek (GALGC10) was perceived to have marginal flow status. Streambank instability and disrupted bank vegetation were noted at the upper site in Buffalo Gulch (BUFLG10). The site on Braziel Creek (BRZLC10) was reported to have alterations to natural channel morphology and low flow conditions. Marginal overall habitat conditions at the visited site on Black Bear Creek (BKBRC10) were attributed to a combination of poor riffle development, monotonous benthic substrates, embedded substrate particles, severe sediment deposition, marginal channel flow status, unstable streambanks, and severely limited riparian zone width.

Six sites were assessed as sub-optimal or marginal in the lower Nevada Creek watershed. Moderate sediment deposition was reported at the upper site on Murray Creek (MURYC10), while the lower site (MURYC20) was perceived to have poor flow status, monotonous benthic substrates, and limited riparian zone width. At the middle site on Douglas Creek (DOUGC20), substrate particles were reportedly embedded and monotonous. Marginal overall conditions at the lower site on Douglas Creek (DOUGC30) were attributed to moderate sediment deposition, embedded and monotonous benthic substrates, poor flow conditions, disturbed streambanks, and limited riparian zones. Streambanks and riparian zones were also disturbed or limited at the visited site on Yourname Creek (YRNMC20). Overall conditions were judged marginal at the Wales Creek site (WALSC10), where moderate sediment deposition and poor channel flow status were implicated. Streambanks were unstable, bank vegetation was in poor condition, and riparian zone width was limited at this site as well. The site on Frazier Creek (FRZRC10) was reported to have abbreviated riparian zones.

Figure 5a. Total habitat assessment scores for 21 sites in the Blackfoot River watershed. September-October 2003.



Tables 5a and 5b. Stream and riparian habitat assessment. These sites were assessed based upon criteria developed by Montana DEQ for streams with riffle/run prevalence. Blackfoot River watershed. September-October 2003.

Max. possible score	Parameter	SVNPC 01	ROCKC 10	ROCKC 20	KLSMC 01	MONTC 10	MONTC 20	MONTC 30	WASHC 10	WASHC 20
10	Riffle development	9	5	8	8	8	8	7	10	8
10	Benthic substrate	8	4	7	5	8	8	8	8	2
20	Embeddedness	11	16	13	12	17	16	17	18	5
20	Channel alteration	14	17	19	14	20	19	20	3	18
20	Sediment deposition	12	6	15	9	12	14	14	20	6
20	Channel flow status	19	8	19	20	7	15	12	16	8
20	Bank stability	6 / 7	8 / 8	9 / 9	9 /9	3 / 8	8 / 8	8 / 9	7 / 8	6 / 6
20	Bank vegetation	9 / 9	7 / 7	8 / 8	6 / 6	9 / 8	8 / 8	7 / 8	3 / 4	6 / 6
20	Vegetated zone	10 / 10	1 / 1	9 / 9	2 / 2	10 /10	9 / 8	7 / 9	1 / 1	4 / 4
160	Total	124	88	133	102	120	129	126	99	79
	Percent of maximum	**77.5**	**55**	**83**	**64**	**75**	**81**	**79**	**62**	**49**
	CONDITION*	**OPT**	**SUB**	**OPT**	**SUB**	**OPT**	**OPT**	**OPT**	**SUB**	**MARG**

Max. possible score	Parameter	JEFSC 10	JEFSC 20	JEFSC 30	GALGC 10	BUFLG 10	BUFLG 20	BRZLC 10	BKBRC 10	MURYC 10
10	Riffle development	9	9	9	7	9	9	9	2	8
10	Benthic substrate	8	3	8	7	6	8	8	1	6
20	Embeddedness	17	5	13	14	14	13	16	3	15
20	Channel alteration	15	15	11	19	18	20	8	19	20
20	Sediment deposition	14	6	7	11	12	17	14	2	10
20	Channel flow status	12	13	19	10	14	19	10	9	17
20	Bank stability	5 / 5	6 / 6	8 / 8	8 /8	4 / 4	8 / 8	5 / 5	4 /4	6 / 6
20	Bank vegetation	3 / 3	2 / 2	8 / 8	8 / 8	3 / 3	8 / 8	5 / 5	1 / 1	8 / 8
20	Vegetated zone	2 / 2	2 / 2	2 / 2	4 / 4	2 / 2	5 / 5	2 / 2	2 / 2	4 / 9
160	Total	95	71	103	108	91	128	89	50	117
	Percent of maximum	**59**	**44**	**64**	**67.5**	**57**	**80**	**56**	**31**	**73**
	CONDITION*	**SUB**	**MARG**	**SUB**	**SUB**	**SUB**	**OPT**	**SUB**	**MARG**	**SUB**

Condition categories: Optimal > 80% of maximum score; Sub-optimal 75 - 56%; Marginal 49 - 29%; Poor <23%. (Plafkin et al. 1989).

Tables 5c and 5d. Stream and riparian habitat assessment. These sites were assessed based upon criteria developed by Montana DEQ for streams with riffle/run prevalence. Blackfoot River watershed. September-October 2003.

Max. possible score	Parameter	MURYC 20	DOUGC 10	DOUGC 20	DOUGC 30	YRNMC 20	WALSC 10	FRZRC 10	RHMDC 01	CLRWF 10
10	Riffle development	6	15	5	3	9	9	9	10	10
10	Benthic substrate	4	16	7	4	6	6	7	9	9
20	Embeddedness	12	16	10	7	16	13	16	15	18
20	Channel alteration	18	15	12	15	16	19	14	19	19
20	Sediment deposition	11	19	14	6	7	6	12	15	17
20	Channel flow status	2	19	15	3	13	8	16	15	15
20	Bank stability	8 / 8	7 / 7	9 / 9	1 / 2	4 / 4	4 / 3	8 / 8	9 / 9	9 / 9
20	Bank vegetation	8 / 8	5 / 5	8 / 8	2 / 3	4 / 4	2 / 2	6 / 7	10 / 10	10 / 10
20	Vegetated zone	3 / 3	7 / 7	10 / 8	2 / 5	5 / 5	5 / 5	4 / 4	10 / 10	10 / 10
160	Total	91	138	115	53	93	82	111	141	146
	Percent of maximum	**57**	**86**	**72**	**33**	**58**	**51**	**69**	**88**	**91**
	CONDITION*	**SUB**	**OPT**	**SUB**	**MARG**	**SUB**	**MARG**	**SUB**	**OPT**	**OPT**

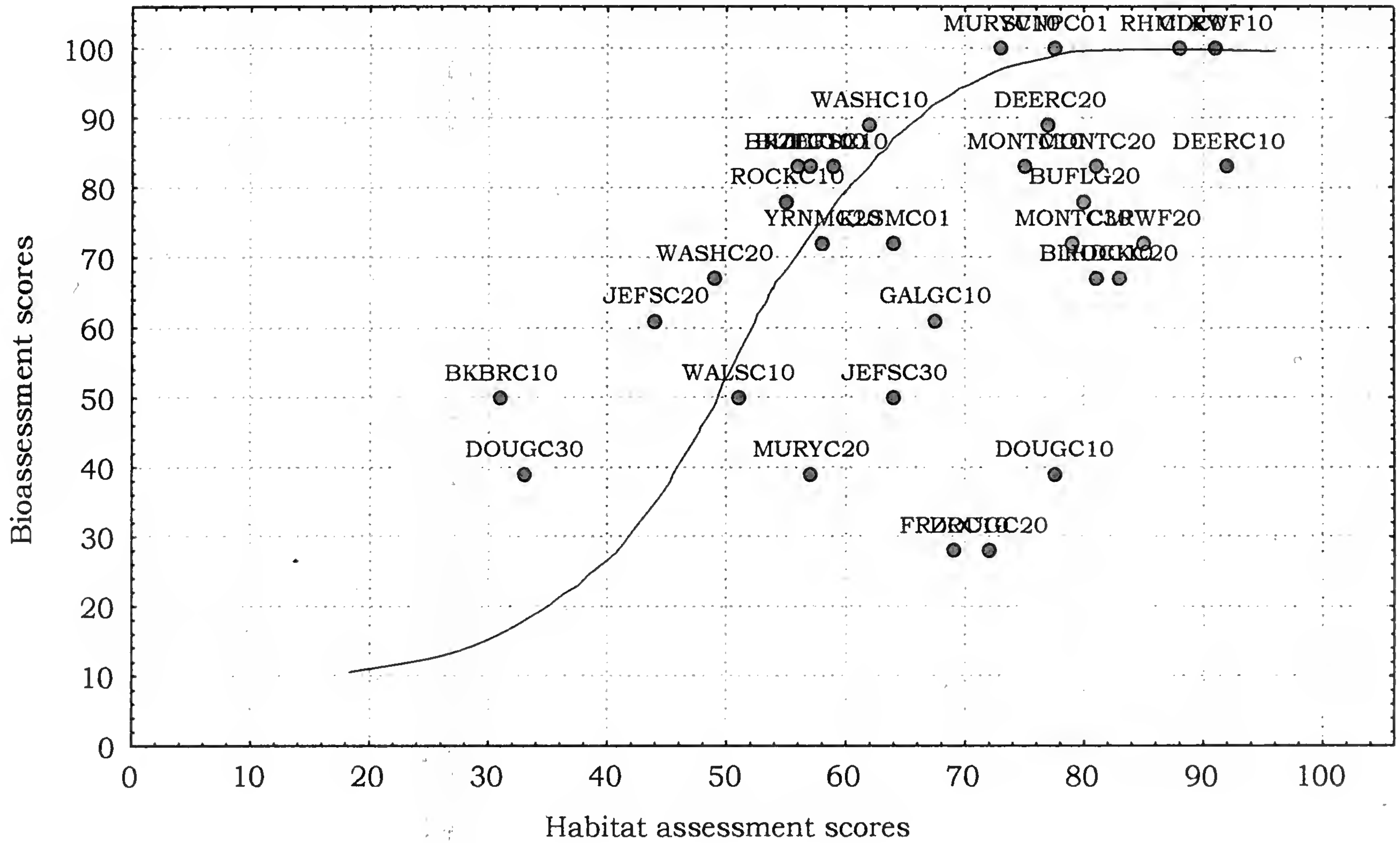
Max. possible score	Parameter	CLRWF20	DEERC10	DEERC20	BLHDC10
10	Riffle development	9	10	8	7
10	Benthic substrate	9	9	9	8
20	Embeddedness	16	18	19	19
20	Channel alteration	16	20	20	20
20	Sediment deposition	15	16	16	14
20	Channel flow status	15	17	14	15
20	Bank stability	9 / 8	10 /9	10 / 7	9 / 9
20	Bank vegetation	10 / 9	10 / 10	10 / 9	6 / 6
20	Vegetated zone	10 / 10	10 / 8	10 / 9	8 / 8
160	Total	136	147	123	129
	Percent of maximum	**85**	**92**	**77**	**81**
	CONDITION*	**OPT**	**OPT**	**OPT**	**OPT**

Condition categories: Optimal > 80% of maximum score; Sub-optimal 75 - 56%; Marginal 49 - 29%; Poor <23%. (Plafkin et al. 1989).

Habitat scores vs. bioassessment scores

When habitat assessment scores are plotted against bioassessment scores, the resulting figure provides an opportunity to evaluate the hypothetical relationship between habitat integrity and water quality. Both factors are critical and interactive determinants of the composition and functional integrity of aquatic invertebrate assemblages. Presumably, high quality habitat, in the absence of impairments to water quality, supports functional, diverse, and sensitive invertebrate assemblages; these are assemblages that attain high bioassessment scores. Barbour and Stribling (1991) have hypothesized that diminishing habitat quality should produce predictable diminishment of bioassessment scores, when water quality is not a further insult. Figure 6 is a plot of habitat assessment scores against bioassessment scores for the September 2003 sampled assemblages of the Blackfoot River watershed. The red line superimposed on the plot roughly represents the hypothetical relationship between habitat quality and biotic integrity given good water quality. In this model, symbols falling in the upper right area of the graph would represent sites with high scores for both bioassessment and habitat assessment; according to this model, these would be unimpaired sites both in terms of habitat integrity as well as water quality. Twelve Blackfoot River watershed sites fall into this approximate area of Figure 6. These are SVNPC01, MONTC10, MONTC20, WASHC10, JEFSC10, BUFLG10, BRZLC10, MURYC10, RHMDC01, CLRWF10, DEERC10 and DEERC20. Some degree of habitat degradation is hypothesized for sites located along or near the downward progression of the red line, that is, when bioassessment scores are falling predictably with decreasing habitat scores. Sites falling into this region include ROCKC10, KLSMC01, WASHC20, JEFSC20, DOUGC30, YRNMC20, and WALSC10. When habitat scores remain high, but bioassessment scores are inordinately low, sites fall into the lower right hand area of the plot. According to the model, these sites support invertebrate assemblages that are impacted mostly by impairment to water quality. The plot in Figure 6 indicates that 11 Blackfoot River watershed sites fall into this area. They are ROCKC20, MONTC30, JEFSC30, GALGC10, BUFLG20, MURYC20, DOUGC10, DOUGC20, FRZRC10, CLRWF20, and BLHDC10. Since the sample collected at Black Bear Creek (BKBRC10) yielded few organisms, it is not possible to interpret the position of the site on the plot.

Figure 6. Total bioassessment scores plotted against habitat assessment scores for sites in the Blackfoot River watershed September-October 2003. (Barbour and Stribling 1991).



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